The Engineer.

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VOL. CLI.—No. 3935] LONDON: FRIDAY EVENING, JUNE 12, 1931 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Monday, 29th June, 1931, for ACCELERATED HOT WATER HEATING at the Telephone Exchange, Hither Green, S.E.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender, may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 7096

SALE BY TENDER OF POST OFFICE ELECTRICAL PLANT.

Tenders are Invited for the PURCHASE, DISMANTLING and REMOVAL of ELECTRIC TRANSFORMERS and SWITCHGEAR, INSTRUMENTS, &c., from the General Post Office (South), Knightrider-street Sub-station, London, E.C. 1.

Forms of Tender, containing all particulars, can be obtained on application to the Controller, Post Office Stores Department, Studd-street Depot (Accounts Section), London, N. 1; or the Post Office Sectional Engineer, 8, King Edward-street, London, E.C. 1.

The plant to be disposed of may be inspected on application being made to the Post Office Sectional Engineer, 8, King Edward-street, E.C. 1.

Tenders will be considered for either the whole or part of the plant.

Tenders will be received until 10 a.m. on Monday, the 22nd June, 1931.

The Postmaster-General does not bind himself to accept the highest or any Tender.

BY ORDER OF THE POSTMASTER-GENERAL.
General Post Office,
June, 1931. 7075

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 30th June, 1931, for ACCELERATED LOW-PRESSURE HOT WATER HEATING, &c., at "COLINDALE" TELEPHONE EXCHANGE, EDGWARE-ROAD, N.W.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 7073

Department of Scientific AND INDUSTRIAL RESEARCH. APPLICATIONS are INVITED for JUNIOR ASSISTANTSHIPS in the Physics and Aeronautics Departments of the NATIONAL PHYSICAL LABORATORY. Candidates should have a good Honours Degree in Physics or Engineering, preferably with some technical or research experience. The scale of pay for a Junior Assistant is £175-15-£235 plus Civil Service bonus (total at present rates £246-£319). There are prospects of promotion to higher grades. Superannuation provision is made under the Federated Superannuation System for Universities.

Application must be made on a form to be obtained from the DIRECTOR, National Physical Laboratory, Teddington, to whom it should be returned not later than June 30th, 1931. 7074

The University of Liverpool.
FACULTY OF ENGINEERING.

MUNITIONS COMMITTEE RESEARCH FELLOWSHIPS.

APPLICATIONS are INVITED for the above FELLOWSHIPS. The Fellowships (two in number) are normally of the value of £250 for the first year and £350 for the second. The appointment shall, in the first instance, be for one year, but may be extended for a second year. Applications should reach the Registrar not later than Monday, June 22nd.
7086 EDWARD CAREY, Registrar.

The Manchester Steam Users' ASSOCIATION.

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Metropolitan Water Board.
TENDERS FOR THE SUPPLY OF STORES, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES and SERVICES, &c., for the period of twelve months, commencing 1st August, 1931:—

Tender No.
2. Brushes, Brooms and Handles.
5. Cotton Waste, Engine Wipers, Hemp, Rope, House Flannel, &c.
10. Lead, Zinc and Glass.
13. Oilman's Sundries, Soaps, Tar, Gas Mantles, Metal Polish, &c.
14. Packings, Rubber Goods, Hose and Leather Belting, &c.
15. Paints, Varnishes, Linseed Oil, Turpentine, &c.
18. Scrap Iron—Purchase and Removal of.
24. Electric Lamps.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 155) or upon forwarding a stamped addressed sack envelope.

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board" and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Wednesday, 24th June, 1931.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Roseberry-avenue, E.C. 1,
5th June, 1931. 7067

The Engineer

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PUBLIC NOTICES

Wellington (Salop) Urban DISTRICT COUNCIL.

NEW WATERWORKS, CONTRACT B. PUMPING MACHINERY.

The above Council invite TENDERS from experienced firms for the MANUFACTURE, DELIVERY and ERECTION of PUMPING MACHINERY in DUPLICATE, capable of lifting 12,000 gallons per hour against a static head of 413ft. The plant is to comprise Two Oil Engines, Centrifugal Bore-hole and Force Pumps, and Accessories.

Copies of the conditions of contract, specification, schedule, form of Tender and preliminary drawing may be obtained from the Council's Consulting Engineer, Edward Sandeman, M. Inst. C.E., 15, Victoria-street, Westminster, S.W. 1, upon payment of a deposit of Five Guineas, which amount will be refunded upon receipt of a bona fide Tender and the return of the above-mentioned documents.

Sealed Tenders, endorsed "Wellington (Salop) U.D.C. Water, Tender for Contract B, Pumping Machinery," are to be delivered to the undersigned by Twelve Noon on Monday, July 6th, 1931.

The Council do not bind themselves to accept the lowest or any Tender.

GEOFFREY L. PEACE,
Clerk to the Council.
Bank Chambers, Wellington, Salop,
8th June, 1931. 7083

River Ouse (Yorks) Catchment BOARD.

APPOINTMENT OF ENGINEER.

APPLICATIONS from qualified Engineers with experience in River (Tidal and Non-tidal), Embankment and Arterial Drainage Works, including the Erection and Maintenance of Outfall Sluices and Pumping Plant, are INVITED for the APPOINTMENT of ENGINEER to the River Ouse (Yorks.) Catchment Board.

Salary £1000 per annum. Offices and staff will be provided. The person appointed will be required to take up duties on an early date, and to devote the whole of his time to the duties of the office.

Canvassing in any form will be a disqualification.

Further particulars of the duties and terms of appointment, together with form of application, may be obtained on request; and applications, together with copies of not more than three recent testimonials, should be sent to the undersigned not later than the 30th June, 1931.

J. CHARLES McGRATH.
County Hall, Wakefield. 7081

PUBLIC NOTICES

County Council of the West RIDING OF YORKSHIRE.
DRAINAGE ENGINEER.

The County Council of the West Riding of Yorkshire invite APPLICATIONS for the POST of DRAINAGE ENGINEER in the County Land Agent's Department, at a commencing salary of £355 to £400 per annum, according to capacity and experience of the selected applicant.

Applicants must have had experience in Arterial and Agricultural Drainage.

Canvassing in any form will be a disqualification.

Further particulars of the duties and terms of appointment, together with form of application, may be obtained on request; and applications, together with copies of not more than three recent testimonials, should be sent to the undersigned not later than the 24th June, 1931.

J. CHARLES McGRATH,
Clerk to the County Council.
County Hall, Wakefield. 7082

Southwold Waterworks Com- PANY, LIMITED.
APPOINTMENT OF FOREMAN.

APPLICATIONS are INVITED for the POST of WORKING FOREMAN. Wages £3 10s. per week inclusive and house free from rent and rates.

Applicants must have experience in all branches of a Company's Waterworks and be competent to take charge of Steam and Diesel Engine Plants.

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Applicants should be between the ages of 30 and 40 years.

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L. S. HARRISSON,
Secretary,
Southwold Waterworks Co., Ltd.,
7088 1, Market-place, Southwold, Suffolk.

SITUATIONS OPEN

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REFERENCE BOX 6977.—First-class Mechanical Engineering Draughtsman Required, Advertisement, May 15th, 1931. The Advertisers wish to thank those who submitted applications for the above appointment, and to notify them that the POSITION IS FILLED. 7097 A

SITUATIONS WANTED

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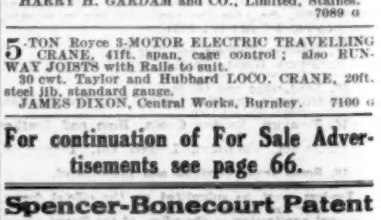


See illustrated advt.

A Seven-Day Journal

The North Regional Broadcasting Station.

A FEW days ago the North Regional broadcasting station began to radiate simultaneous transmissions from the National and Regional transmitters for the purpose of reception tests. For some weeks past the Regional wave length has been on a permanent basis, and during the past fortnight engineers' tests have been made on the National wave length. The introduction of the public reception tests on the two wave lengths is the forerunner of the official opening of the North Regional station as a twin transmitter. As at present arranged, the tests will be made on week-days between 5.15 p.m. and 6 p.m. and 10.45 p.m. and midnight, whilst on Sundays they will be made from 3 p.m. to 6.15 p.m. Before the station takes over the distribution of alternative programmes on a full-time basis, the tests will be further extended, and this testing period will give listeners ample time in which to make any necessary adjustment to their receivers. As it is possible that some listeners within the area of the station may experience difficulty in separating the two transmissions, the B.B.C. has issued an informative pamphlet on "Selectivity," in which useful hints and diagrams are given to assist people to make crystal and valve receivers more selective. With the introduction of the North Regional programmes on May 19th, all other transmitters in the northern region, with the exception of the Newcastle transmitter, were suspended. The North Regional high-power station is unable to give an adequate service to the Newcastle district, and the local transmitter has therefore been retained.

The Greenwich Observatory.

ON Saturday, June 6th, the Board of Visitors met at the Greenwich Observatory to receive the report of the Astronomer Royal for the year ending May 10th, 1931. One of the matters referred to in the report is that as the result of a resolution of the Board last year, drawing attention to the need for a new transit circle, the Lord Commissioners have agreed to purchase an instrument of that kind. The transit circle now in use was installed by Airy in 1851, but since the observations made with it exceed half a million, it is not surprising that it is now considered to be worn out. Discussion is now proceeding with Messrs. Cooke, Troughton, and Simms with reference to the details of the new instrument. As regards the usual statistics given in these annual summaries, it is shown that more than 11,000 meridian observations were made with the transit circle, which is 2000 more than the number given in the report last year. Included in these are observations of the sun on 131 days and of the moon on 79 days, these being less than usual, apparently on account of the unfavourable meterological conditions that are mentioned in another part of the report. Tabular statements covering a series of years give comparisons of the positions of the sun and moon found from observations with their computed positions given in the "Nautical Almanac," and it is shown that the tables used require some emendation. Extra-meridian work carried out during the year included the observation of double stars with the 28in. equatorial and the determination of stellar parallax from photographs taken with the 26in. reflector, the instrument presented to the Observatory in 1894 by Sir Henry Thompson. The work of both these departments suffered somewhat from adverse weather, and the stellar photography was further interrupted during the winter months by the necessity for using the instrument in order to take photographs of the minor planet Eros, which was then very near to the earth.

Industries and the Land Tax.

THE Federation of British Industries, desiring to record a most emphatic protest against the proposed taxation of land values as a method of taxation in industry, has sent a memorandum discussing the objections to such a tax to the leaders of the three parliamentary parties. It is pointed out in the memorandum that the Finance Bill introduces an entirely new principle into the taxation of industry in that for the first time a tax is to be imposed upon one "tool" without consideration of the earnings derived from its use. The incidence of the tax, it is claimed, will vary capriciously, and most inequitably, not only as between industry and industry, but also as between different units in the same industry. Certain ranges of industry need considerable land areas for their operation, as distinct from those of the factory type, while within one branch many old-established factories are now situated in densely populated urban districts where they have a high frontage value, as compared with more recently erected works established in more open areas, which, although more convenient and economical, have no correspondingly high site values. This aspect is of special importance in the older manufacturing centres, such as Lancashire, where it is thought that the variation in the incidence of the tax may prove a deciding factor as to whether some mills can continue in operation or others reopen. The proposed tax would inevitably increase costs and might prove the determining factor from a psychological point of view in maintaining works in operation or reopening them. The Federation has come to the conclusion that the only effective method of obviating the effects to industry will be the introduction of amendments either exempting industry entirely from the operation of the Bill or at least exempting land used for industrial purposes from taxation. Amendments are therefore being prepared with that end in view.

Science in Industry.

THE new headquarters of the British Non-ferrous Metals Research Association in Regnart Buildings, Euston-street, was, as noted on another page of this issue, opened last Monday, June 8th, by Lord Rutherford. Speaking at the ceremony, Lord Rutherford referred to the need for close liaison between scientists and industrialists. He said that much had been done by the Association to simplify the results of research, so that the time lag between scientific discovery and its use in industry could be restricted. He regarded that as an important matter. When estimating the results of scientific research, there was always a danger that too narrow a point of view might be adopted. A definite return could not be expected each month. One of the marvels of the age was the development of the motor car since 1900, for which special steels and alloys and many other materials were required, each of which represented a great deal of research work. Sixty or seventy metals were available for research, but only six or seven had been investigated by the Association. What of the remainder? He was certain that 90 per cent. of the processes used in industry could be improved by the application of science. In the new building there would be no lack of research work for many years, even if the staff was much multiplied. The future of the metal industry and that of many others was ultimately dependent on the application of science to industry. He believed that in the years to come only those industries which had shown their power of applying scientific knowledge to the problems they met and to the improvement of their methods of production would survive.

Loss of H.M.S. Poseidon.

LAST Tuesday, June 9th, H.M. Submarine "Poseidon" was sunk in collision with a merchant vessel, 21 miles north of Wei-hai-wei, in China. She was rammed by a Chinese vessel, the "Yuta." H.M. ships "Berwick," "Cumberland," and "Hermes" soon arrived at the scene of the collision, and later the submarine parent ship "Medway," the destroyer "Stormcloud," and the sloop "Marzion" were reported to be at the scene of the disaster. Owing to the fact that H.M.S. "Poseidon" appears to have been travelling on the surface, the loss of life, though serious, was not as great as that which has occurred in previous accidents in which submarines have been involved. Five officers and twenty-eight men are reported to have been saved, while eighteen ratings are missing and two that were picked up have since died. The "Poseidon, as her name implies, is a "P" class submarine; she was built by Vickers-Armstrongs, Ltd., launched in 1929, and went into commission at Barrow in March last year. She arrived at Hong Kong in February this year. She has a displacement of 1570 tons on the surface and 2040 tons submerged, with speeds of 17·5 knots and 9 knots respectively. Her armament consists of one 4in. gun and eight 21in. torpedo tubes, six of which are in the bow and two in the stern. According to later reports, six of the survivors made their escape from the sunken ship by the use of Davis' submarine escape apparatus. Of the eighteen men imprisoned below, contact has already been made with eight, and as the hope is held out that salvage operations may be successful within twenty-four hours, there is a possibility that these men may be rescued.

The Electrification of British Railways.

ACCORDING to the political correspondent of the *Daily Telegraph*, the statements that have been published recently stating that the railways have accepted the principle of the Weir report are not strictly accurate. It appears that the true position is that the four main line companies have been considering the proposals embodied in the report for some weeks, and that while it is considered that the problem of electrification has been dealt with most ably by the Committee, the scheme has not received the support of the experts of the companies, even in principle. A suggestion is made that the report is being used for political purposes, and that the public may easily be misled as to the facts. The General Managers' Staff Conference is considering the reply to be sent to the Minister of Transport, stating the views of the companies. Railway engineers hold that the question rests largely upon the cost of current, and believe that no guarantee that the price of the current will be that anticipated when the Electricity Bill passed through Parliament exists. It is pointed out that all sidings belonging to industrialists would have to be electrified at the cost of the owners, and that it may not be possible to ask industry to incur this expense for some years. The claim is also made that the plans embodied in the Weir report have not been successful in at least one case on the Continent. The electrification of suburban lines, however, will be an advantage to the public, and is bound to come; but it is pointed out that that is a very different thing to the plans outlined in the report.

The Do X Flying Boat.

THE "Do X," the large German flying boat, reached Natal, Brazil, at two o'clock on Friday afternoon, June 5th, and has thus completed the Atlantic flight that it began some months ago. It has been delayed frequently owing to a variety of mishaps. From Spain the route of the "Do X" was *vid* the Canary Islands to Bolama in Portuguese Guinea, and thence to the Cape Verde Islands, Fernando Noronha, and Brazil. On the ocean lap from Porto Praya in Cape Verde Islands to Fernando Noronha on June 4th, the machine was reported by a ship to have fallen into the sea, and considerable anxiety was aroused. Although fitted with a wireless installation, the machine was unable to deny the report for some hours, owing to interference from the transmitters on ships. This ocean lap of 1429 miles was completed in 12 hours 26 min., the machine having left the Islands at 10.50 a.m. A welcome was provided at Natal by a crowd of some thousands, and the municipal authorities went down to the river to meet the thirteen airmen. It is reported that the machine will probably continue its flight later to the United States across the Caribbean Sea.

An Aerodrome in Central London.

WITH a view to revolutionising London air traffic a £5,000,000 scheme is being planned by a committee of business men, architects and engineers, who propose to erect an overhead aerodrome at King's Cross. Subject to the necessary Parliamentary and other powers being obtained, the scheme will involve the construction of a huge central air and rail terminus on a site now occupied by railway sidings near King's Cross and St. Paneras stations. The proposal includes the re-planning of goods yards, and the construction of warehouses suitable for supporting an overhead concrete landing ground. The committee includes Sir Walter Peacock. Negotiations are proceeding with the various interests involved and a model of the scheme was exhibited at the Institution of Civil Engineers' conversazione held on Wednesday last. It is estimated that once the preliminary difficulties have been overcome the scheme would take about three years to complete. In effect, it provides for the removal of the Croydon aerodrome to London and the setting up of a terminus for passengers, mails and goods by air road and rail in the heart of London.

The Military College of Science, Woolwich.

ON Wednesday afternoon the Commandant, staff, and students of the Military College of Science, at Woolwich, held an "At Home." It was a very pleasant function, with music and many ladies; in fact, there was such a concourse of visitors that it was not easy to move about the building—and it is a big one. We gather that the general idea of the function was to demonstrate the efforts which are being made to help in the education of the officers and men of our Army in the "mechanisation" which is now going forward. To this end a large amount of plant and apparatus, such as is generally associated with a technical college, has been collected, but, naturally, it has a more direct bearing on military affairs. We were impressed with the enthusiasm of the professors and demonstrators, and with their ability in explaining their subjects, for they held the attention of the ladies quite as well as the engineers. We understand that the number of men passing through the College is about 100 a year.

Trade with Canada.

ON Wednesday of this week the Federation of British Industries published the report submitted to its Grand Council by a Mission—consisting of Sir James Lithgow, Sir Arthur Duckham and Mr. Moir Mackenzie—which recently returned from Canada. The report is divided into three parts, giving facts, conclusions and recommendations. The Mission interviewed the Canadian Manufacturers' Association, the banks, Development Commissions, Harbour Boards, &c., from which the following facts, among others, were derived. The Dominion was determined to continue the development of its natural resources and maintain and strengthen its industrial and manufacturing position; but at the same time it desired to purchase goods from Great Britain and the Empire in preference to buying them in other countries. The Mission brings forward conclusions pointing out that for the prosperity of the Empire trade must be reciprocal between the units. The development of Great Britain's trade with Canada must depend upon the acquirement of business at present in the hands of foreign countries, besides the development of new lines. The co-operation of home producers is regarded as essential if a good selling and service force is to be built up in Canada.

High-speed Worm Drives.

By H. WALKER, B.Sc.*

DESIGN AND MATERIALS.

WORM gear forms an ideal drive, and in many cases the only possible drive between shafts lying at right angles and running at high speeds. When correctly designed and accurately manufactured from suitable materials a worm drive is capable of running silently and efficiently at high speeds, and will transmit comparatively heavy loads with almost any desired ratio of reduction. The alternative form of drive for shafts at right angles is the bevel gear, and although this drive has a certain useful field of application, especially in the form of spiral bevel gears and hypoid gears, it does not possess the same advantages as worm gears and its use is limited to certain cases in which the disposition of the driving and driven mechanism calls for some special feature of the bevel drive which cannot be obtained with worm drive. If, for instance, the driving and driven shafts must lie in the same plane, then bevel gearing must be used, but more as a matter of necessity than of choice.

The applications of worm gears to high-speed work are mainly governor drives and oil circulating pump drives for turbines, rear axle drives for racing cars, speed increasing gears for fan drives, centrifuges, separators, pumps, &c., and certain special drives for machine tools. The worm speed in some of the above cases may be as high as 10,000 r.p.m., and even at this speed the gears will function satisfactorily, provided due precautions are taken in the design, manufacture and mounting of the gears. So far there has been found no practical application which limits the use of worm gear owing to high speed. Similarly, no application has been found which limits the use of worm gears owing to high peripheral speed. Rubbing speeds up to 6000ft. per minute are often met with in practice, and in exceptional cases much higher speeds are employed. The rubbing speed is the actual speed at which the worm thread surface passes over the wheel tooth, and is equal to the tangential speed of the worm thread resolved along the thread helix.

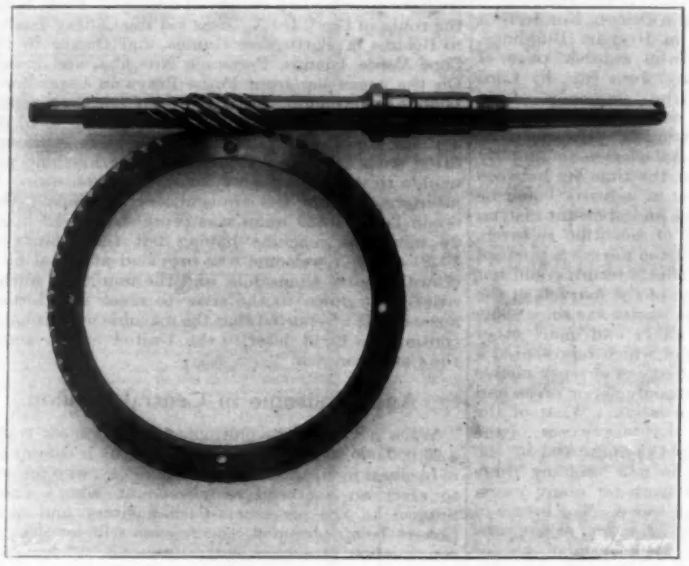


FIG. 1—WORM DRIVE FOR 10,000 R.P.M.

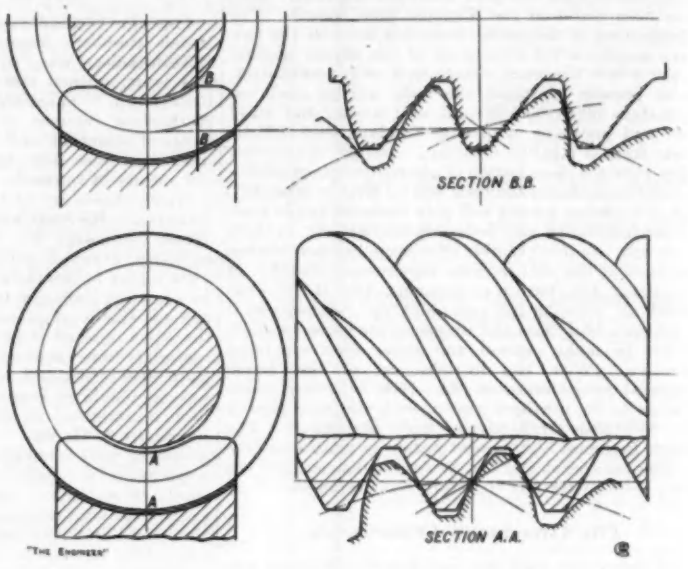


FIG. 2—SECTIONS OF A WORM AND WHEEL

It will readily be appreciated that at such speeds as those quoted above there is no room for faults either in the materials or manufacture of the gears. A nine-thread worm running at 10,000 r.p.m.—see Fig. 1—means that 90,000 teeth are moving in and out of mesh every minute, or 1500 teeth every second. Inaccuracies in pitch will cause minute but rapid accelerations and decelerations of the worm wheel, resulting in vibration and noise. Such errors, combined with inaccuracies in mounting, or in tooth or thread profile, also result in faulty tooth contact; the tooth pressure, instead of being distributed over the theoretical lines of contact, is concentrated on certain parts of the tooth, increasing the specific loading and resulting in high local surface stresses which may in time cause pitting or rapid wear of the wheel teeth.

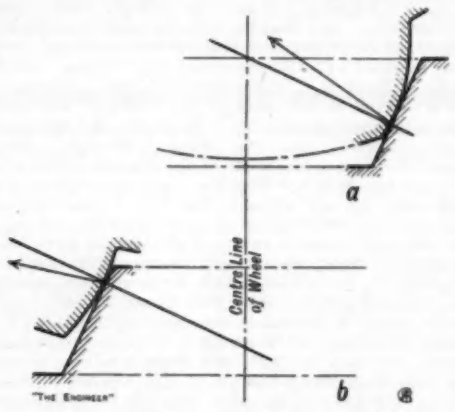
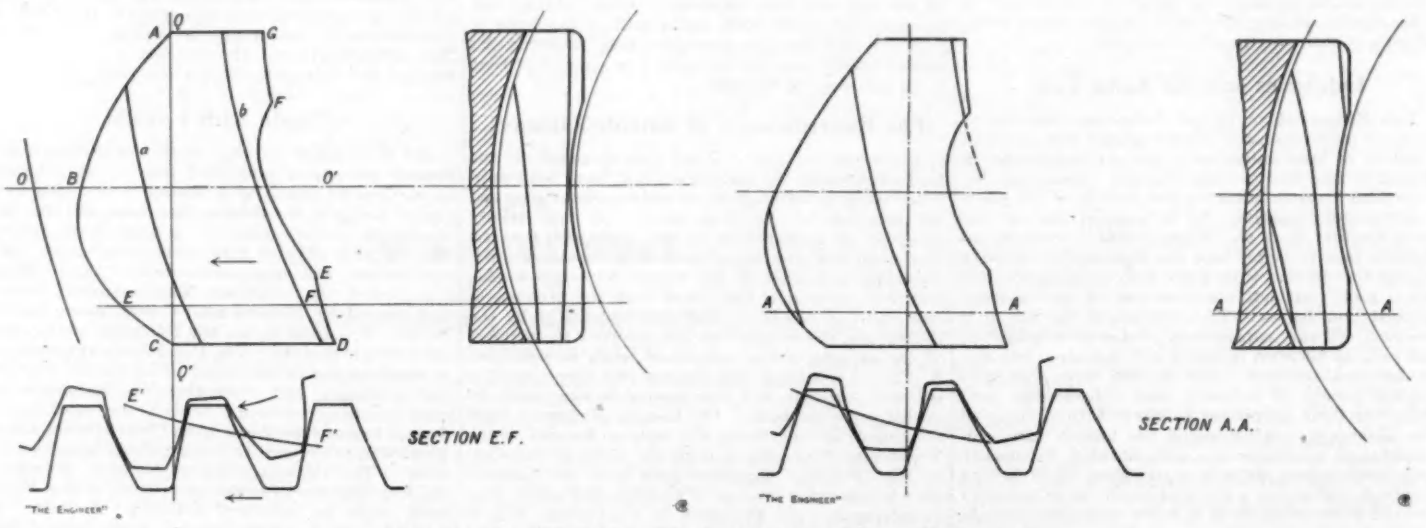


FIG. 3—APPROACH AND RECESS CONTACT

This question of accuracy is not one which depends solely on the skill of the workman and the accuracy of his machines. It depends also to a considerable extent on the design of the gears and the selection of a tooth form which lends itself to accurate generation. In designing the gears the object is primarily to make the centre distance and general proportions such that the most compact drive is obtained whilst maintaining a suitable factor of safety. It will be appreciated that, although an increase in centre distance and general proportions will reduce the specific surface stress tending to cause abrasion under a given load, this increase will also cause a corresponding increase in the rubbing speed of the gears. Since higher rubbing speeds call for lighter loads, it follows that in designing the gears a balance must be obtained such that the rubbing speed is kept as low as possible whilst maintaining a suitable factor of safety against wear of the teeth. This adjustment, of course, requires a considerable knowledge of the results obtained from gears in actual practice, but, especially when this knowledge is coupled with the results of laboratory tests on a testing machine such as the machine described later in this article, it is possible to determine accurately the required balance between rubbing speed and tooth pressure.

Having arrived at this stage, the question of thread form must receive consideration. In discussing this subject, reference will be made mainly to the thread form in its effects on comparatively low lead angle worms such as are met with in high-speed worm drives for governor and pump drives on turbines, these being the principal applications of high-speed worm drives. For such applications the worm has usually to be bored to fit on to a large diameter shaft. The pitch diameter of the worm must therefore be large, and hence the lead angle must be low as compared with most other applications of worm drive.

The primary essential of a worm thread form is that when it is meshed with a suitable wheel the gears shall be theoretically capable of transmitting uniform angular velocity; that is to say, when the worm is turned at a uniform rate, it must be theoretically capable of propelling the wheel with uniform angular velocity and without intermittency of motion. There have been many conflicting opinions expressed as to whether worm gearing is really capable of theoretically fulfilling this condition. Generally speaking, the consensus of authoritative opinion is that worm gearing of the straight-sided linear type fulfils the condition, although one authority has stated that there is only one thread form which will fulfil the condition, the particular thread form referred to not



FIGS. 4 AND 5—CONTACT AREAS IN LOW LEAD ANGLE WORM GEARS

* Technical Engineer, John Holroyd and Co., Milnrow.

being the straight-sided linear type. The truth of this matter is that there is an infinite number of thread forms which will give uniform angular motion.

In order to prove this statement it is only necessary to refer to the method of producing worm gears. The essence of the hobbing process for cutting worm wheels is that a hob, the successive positions of whose profile sweep out what corresponds to a complete envelope of the worm threads, is made to revolve with uniform angular velocity, whilst cutting the tooth spaces in a wheel which also moves with uniform angular velocity. Assuming that the cutting of the teeth is carried out to perfection, then a perfect worm, gearing with this wheel, would reproduce the uniform relative velocities which obtained between the hob and the wheel, provided that the tooth proportions are such as to ensure overlap in the tooth engagement—that is, one tooth of the wheel must not be out of mesh before the next one comes into action. In order to show that this overlap of tooth engagement can be easily obtained it is only necessary to consider the tooth action on the central—axial—section of a straight-sided linear worm thread and wheel. In this case the worm section is similar to that of an involute spur rack, and the section of the wheel is similar to that of an involute spur pinion. Uniform rotation of the worm causes the thread profiles on the section under consideration to advance at a uniform rate and the wheel, since it has conjugate teeth, must revolve uniformly. As in the case of an involute rack and pinion, overlap of tooth engagement on the central section is sufficient to impart uniform angular velocity to the gears. It is not in any way inherent to the argument that the worm profile shall be straight sided on the linear section. It may be a curve of any form provided it fulfils the condition that the wheel profile generated by this curve has successive normals which intersect the pitch line of the wheel at successive points. If this condition is not fulfilled interference will take place, and although this interference does not necessarily destroy the uniformity of angular velocity—the interference is cut away by the hob—it results in a loss of contact and consequently reduces the load-carrying capacity of the gears.

The same remarks hold good regarding the contact on sections other than the mid-section of a worm and wheel. Fig. 2 shows two sections of a worm and wheel taken at right angles to the wheel axis. The central section is of the straight linear type, and the other section has been obtained in accordance with this proviso. In each case it will be seen that correct contact is obtained without interference, so that, although contact on the central section is sufficient to ensure uniform angular velocity transmission, additional contact is obtained on the offset sections, resulting in lines of contact which extend across the faces of the teeth. The actual formation of these lines of contact can be varied by using different thread shapes and by varying the thread proportions. Fig. 4 shows the nature of the lines of contact on a typical low lead angle, straight-sided linear section worm. $O O^1$ is the axis of the worm, and $Q Q^1$ the axis of the wheel. The area within which contact takes place is bounded by the full lines passing through the points A, B, C, D, E, F, G. This surface is a distorted plane known as the "zone of contact," and the lines made by the intersection of the zone of contact with the thread surface are lines of contact. Any thread which lies within the zone of contact must have a line of contact where it intersects the plane. Such lines of contact are represented by *a*, *b* for one particular angular position of the worm. When the worm revolves the lines of contact move along the stationary zone in the direction of the arrow, and pass out of contact, being succeeded by other lines of contact.

The lower diagram in Fig. 4 shows the actual tooth contact on a section of the worm wheel near the extremity of the wheel face, corresponding to the line E F on the contact zone. $E^1 F^1$ is the line of action or path of contact for the driving face under consideration, the apparent motion of the worm threads, and the real motion of the wheel teeth, being in the directions indicated by the arrows. It will be noted that on this section the pressure angle of the profiles on the driving side is comparatively low, and that the larger part of the contact takes place before the pitch point is reached. Both the low pressure angle on this section and the fact that the contact takes place largely on the approach side of the pitch point contribute to make the straight-sided linear section worm deficient in load capacity.

It is well known that under heavy loads pitting of the wheel teeth starts on the leaving side of the worm wheel tooth. The fact that a low pressure angle occurs in this section means that the relative curvature of the profiles at the point of contact is high. Consequently, the "closeness of fit" of the contacting surfaces is low, thus increasing the specific tooth pressure for a given load, and increasing the possibility of failure through high surface stress. There is also a secondary contact which takes place on the leaving side of the wheel tooth, *i.e.*, certain points on the worm thread which have already been in contact on the entering side of the tooth, come into contact again on the leaving side, thus resulting in poor lubricating conditions on the leaving side.

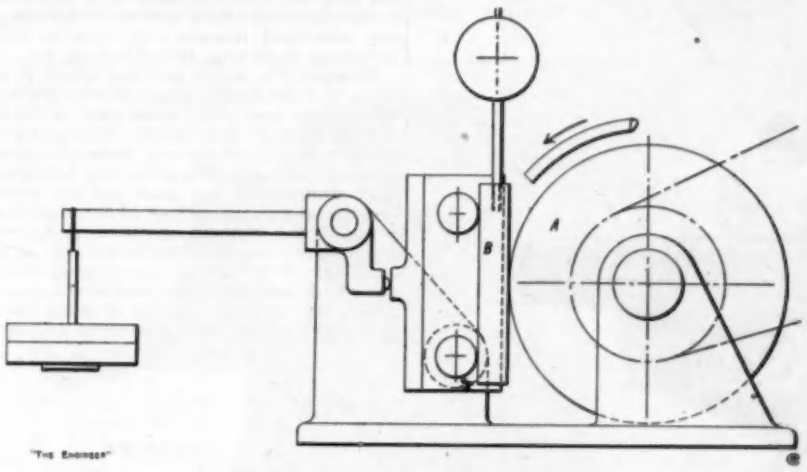


FIG. 6—HOLROYD FRICTION TESTING MACHINE

The long approach to the pitch point results in increased sliding velocity between the teeth, in a direction at right angles to the tangential movement of the worm thread. This high sliding velocity on the leaving side of the tooth is a material addition to the tangential sliding component velocity, and in the past has been overlooked in estimating rubbing speeds. Moreover, the effect of a sliding velocity on the approaching side of the pitch point is conducive to greater frictional losses than if the contact were on the opposite side of the pitch point. Examination of Fig. 3 verifies this fact. In Fig. 3*a*, which illustrates "approach" contact, it will be seen that the tooth force exerted on the wheel at the point contact is inclined away from the common normal and towards the centre of the wheel. It is quite conceivable that if the pressure angle were high enough, the worm could not be made to drive the wheel, because the tooth force would act through, or beyond, the centre of the wheel. Fig. 3*b*, on the other hand, illustrates "recess" contact. The direction of sliding is now in the opposite direction, so that the tooth reaction is inclined as shown, and it is impossible to stop the gears from driving, no matter how high the pressure angle may be.

Another defect of the straight linear section worm is the difficulty of accurately grinding the profile. The grinding wheel, if it is to produce a correct profile on this type of worm, cannot be made straight-faced, and although it is possible to generate the required shape on the wheel by generation from a diamond moving in a straight line corresponding to the linear profile of the worm, or by using a hyperbolic cup-shaped wheel, the former process is too complicated to give accurate results in practice, and the latter method is not a practical proposition for worms of normally useful proportions.

In order to overcome these defects, the Holroyd process of worm thread design and generation was developed. The threads of the worm are ground from an abrasive wheel formed by a straight line movement, and by correct attention to the design and tooth proportions—mainly with regard to the position of the pitch plane of the worm in relation to the overall and root diameter of the threads—the difficulties of the straight linear worm are largely overcome, as will be seen from Fig. 5, which shows the contact obtained on a pair of Holroyd gears of the same general proportions as those in Fig. 4. It will be seen from Fig. 5 that the contact at the leaving side of the tooth takes place largely on the recess side of the pitch point. The pressure angle on the leaving side is also increased, thus increasing the "closeness of fit" of the tooth surfaces, and reducing potential wear of the teeth. The velocity of sliding in a plane at right angles to the wheel axis is reduced to a considerable extent on the leaving side of the wheel tooth, and concentration of the lines of contact on this side of the tooth is avoided.

The hollow, or enveloping, type of worm gear is usually precluded from use on turbine governor gears, because in many of these drives the worm shaft has a small amount of axial movement, and the slightest axial movement from the true central position of a hollow worm is sufficient to destroy the correctness of contact and to cause uneven angular movement of the gears to a sufficient extent to produce noise and rapid wear. The hollow worm is capable, when correctly manufactured and mounted, of transmitting what can be considered for practical purposes as true uniform angular velocity, and it is quite likely that if it could be manufactured and mounted with theoretical accuracy it could, except for the limitation above mentioned, be made to give as good results as the parallel worm. In actual practice, however, the mechanical difficulties to be overcome are too great to give the required accuracy in a hollow worm. The disadvantages of the hollow worm have, during recent years, been given sufficient publicity and do not need amplifying here.

An important contributory factor to the success or failure of high-speed worm drives is the choice of materials for the worm and wheel. In selecting a suitable bronze for the wheel it should be borne in mind that the particular application for which the gears are to be used will affect the choice of material. In governor and pump drives, for instance, the load is usually comparatively light, and the actual physical strength of the bronze is not so important as its wear-resisting properties at high speeds. In worm gear drives for rear axles, on the other hand, the requirement is physical strength combined with wear resistance at slow speeds.

In order to test the capacities of various mixtures of phosphor-bronze in combination with different grades of steel the Holroyd friction testing machine, which is illustrated diagrammatically on Fig. 6, was devised. In using this machine a disc A is pressed into contact with a plate B by means of a lever sup-

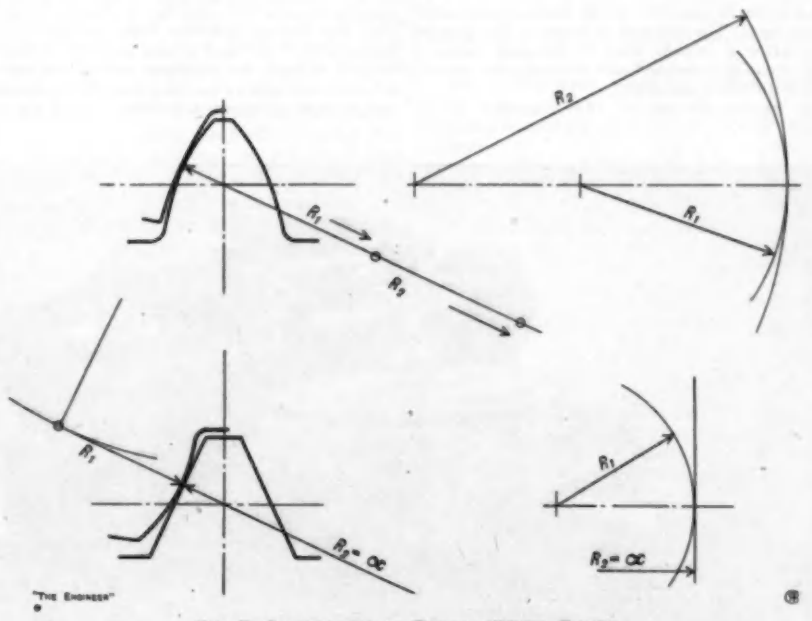


FIG. 7—CLOSENESS OF FIT IN WORM GEARS

porting a dead weight. The disc may be of bronze and the plate of steel hardened and surface ground or, alternatively, the disc may be of steel and the plate may have a small insert of the bronze to be tested. The disc is revolved in contact with the plate and the contacting parts are fed with lubricant. The spring balance attached to the plate, which is supported at the back on rollers, enables a direct measurement to be made of the frictional effort, and the coefficient of friction for the materials tested can thus be calculated from direct readings. The effects on the coefficient of friction of variations in rubbing speed, materials, quality of lubricant, and temperature of lubricant can thus be easily determined. The resistance to wear offered by materials of various compositions and casting processes can be readily gauged by revolving a hardened steel disc in contact with a small piece of the bronze, the spring balance not being used in this test. The amount of wear on the bronze test piece, after a certain time of running under a fixed load, is easily measured and comparative results obtained for different materials.

Another important use of this machine is its employment to determine the precise effect on rate of wear, of varying relative curvatures of the test pieces. This factor has a direct bearing on the calculation of the stresses in worm gears, as will be seen from Fig. 7, which shows in the lower view the contact between a worm and wheel tooth on the axial section, the worm being of the straight-sided type. In this case the worm thread has an infinite radius of curvature at the point of contact, and the wheel tooth has a radius of curvature equal to the distance from the point of contact to the base circle. In the upper diagram of Fig. 7 is shown the contact between a worm profile of curved formation and a conjugate wheel tooth. In this case the centres of curvature are both on the same side of the worm profile. In other words, the "closeness of fit" of the contacting surfaces is different in the two cases, and it will be obvious that when placed under load the narrow band of contact which results from the flattening of the surfaces under pressure will be wider in the second case than in the first case. It is well known that surfaces wear better when they fit more closely. The improved wearing properties of a 20 deg. pressure angle spur gear as compared with a 14½ deg. spur gear are directly attributed to the increased closeness of fit obtained by increasing the pressure angle. So far as the writer is aware, however, no direct measurements have ever been made of wear in relation to the relative curvatures of contacting surfaces. It will be seen that the testing machine described above fulfils the requirements for such a test, since it is merely necessary to change the diameter of the test disc in order to alter the relative curvature at the point of contact, and thus to ascertain the effect of such an alteration. For the purposes of this particular test the flat surface against which the disc presses must be kept moving, for otherwise a small hollow would be worn in the plate and the relative curvature would thus change during the test from the original value.

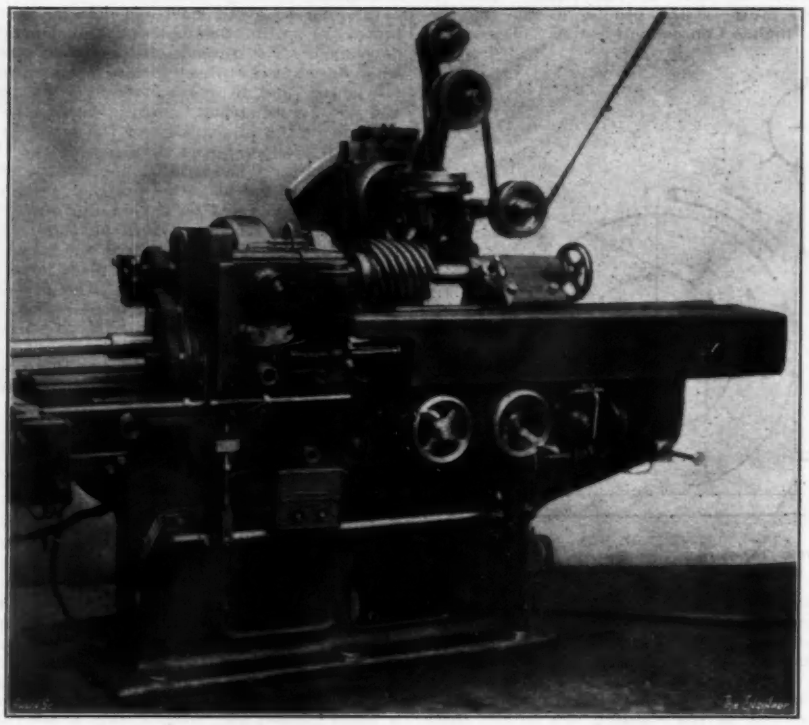


FIG. 8—HOLROYD WORM THREAD GRINDING MACHINE

FIG. 9—HOLROYD WORM WHEEL GENERATING MACHINE

THE MANUFACTURE OF HIGH-SPEED WORM DRIVES.

Ranking equally important with questions of design and materials is the manufacture of the gears. If the full theoretical advantages of a gear are to be obtained in practice it is essential that accuracy of manufacture should be maintained. The effects of inaccuracies in the gears are:—(1) The theoretical contact between the teeth is not obtained and the result is that certain "high spots" on the teeth have to carry the entire load. This effect results in heavy local surface stresses which tend to cause rapid wear or pitting of the teeth. The nearer the approach to theoretical accuracy the better will be the distribution of the load, and, of course, a low specific load results in less wear of the teeth. (2) Inaccuracies cause vibration and noise. Both these effects are particularly objectionable when emanating from worm gears fitted to so silent a unit as a modern turbine, besides being a general indication of inefficiency.

The following notes regarding the manufacture of the gears are therefore made with reference only to those operations which control the accuracy, as it is not considered necessary to refer to the normal operations of turning, thread milling, &c.

Between the worm and the wheel, it is on the worm that the highest degree of accuracy is required, because any wear which takes place on the wheel will tend to eliminate inaccuracies, whereas if the inaccuracies exist in the worm they cannot be eliminated by running the gears. The operations which govern the final accuracy of the gears are the worm thread grinding and the generating of the wheel teeth. The worm thread grinding operation is, for the reason given above, the more important. It is, moreover, more difficult to ensure accuracy in the worm than in the wheel, because of the numerous sources of error which can occur in a thread grinding machine. It was with a realisation of these facts that the Holroyd

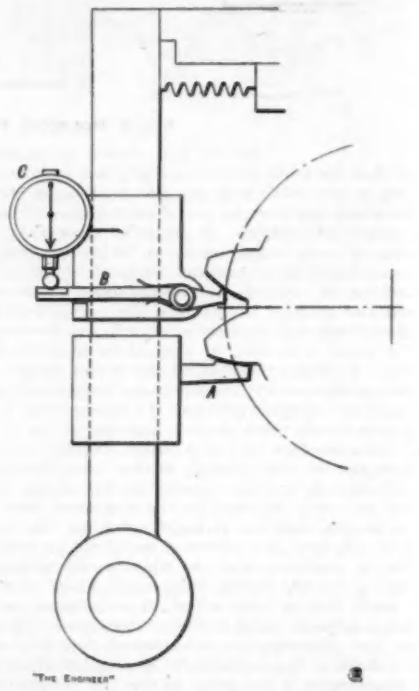


FIG. 10—WHEEL TOOTH PITCH MEASUREMENT

thread grinder, illustrated in Fig. 8, was designed. This machine was built with the express intention of using it for grinding the threads of worms for turbine governor drives, and in order to maintain its accuracy is used for no other purpose.

So far as the general principle of the machine is concerned, it follows the usual design of a thread grinder in that the slide carrying the revolving worm is traversed past the grinding head by means of a lead screw, but it differs in several other respects. The amount of gearing used in the machine is reduced to a minimum. It has no differential, because this item increases inaccuracies. The few gears which are used in the main drives of the machine take the form of spur gears, hardened and ground on the tooth profiles. For certain leads, hardened and ground spur wheels are available for change gears, and the lead screw itself is specially corrected for pitch error.

The dividing at the end of each stroke of the grinder is carried out by means of a dividing plate with a single slot. This dividing plate is driven by means of a small auxiliary motor, and motion is transmitted from the dividing plate, through change gears, to the lead screw nut which is attached to the slide. There is a main motor for driving the work and the lead screw. This motor automatically reverses after each grinding stroke, to bring the slide back to its initial position, and is automatically cut out of operation when the dividing motor is working. The main motor drives through a hydraulic variable speed mechanism, which enables the forward or return movement of the table to be varied immediately by turning one of two handles. Since the dividing and lead screw motions are separate and self-contained it is easy to detect and remedy any errors which may creep into the machine, and the results can, therefore, be kept constantly up to a standard.

The cutting of the wheel teeth is carried out on

a Holroyd worm wheel generator similar to that shown in Fig. 9. This machine employs a relatively large worm wheel for driving the table. Any errors in the dividing worm wheel driving the table are reproduced on the worm wheel blank, but are reduced in proportion to the relative sizes of the worm wheel blank and the table-driving worm wheel. It is, therefore, important on a machine of this type to keep the table-driving worm wheel as large and accurate as possible. The machine has a tangential feed which causes the hob slide to travel tangentially past the worm wheel blank, and a differential is incorporated to compensate the feed motion.

The remaining factor which controls accuracy of production is the accuracy of the cutting tool for the worm wheel. In cases involving the production of quantities of similar gears a full hob is made, and in order to eliminate hardening errors the hob is profile ground, using a special grinding attachment on a relieving lathe. In cases in which the diversity of size does not justify the manufacture of a hob, a single-point, or fly, cutter is used. It is important that such a cutter should be ground in position in the cutter bar, and that it should preferably be ground on the worm grinding machine, using the same setting as is used for grinding the worm, in order to ensure exact similarity between the worm profile and the cutter profile, relief being given to the cutter afterwards.

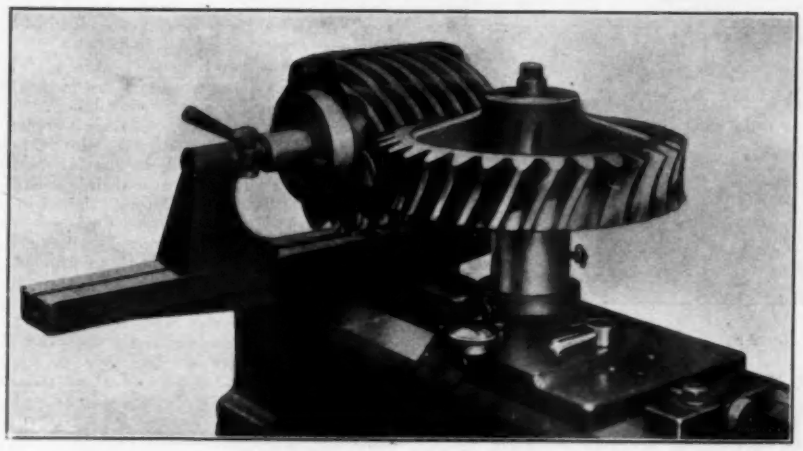


FIG. 11—WORM AND WHEEL TESTING DEVICE

TESTING.

Apart from routine inspection, the important factors to be tested in a pair of worm gears are the accuracy of spacing of the wheel teeth, the spacing of the worm threads, on both a linear and a transverse section, and the profiles of both worm and wheel. The pitch errors in the wheel teeth are detected by comparative measurements from tooth to tooth, using an instrument diagrammatically illustrated in Fig. 10. A tooth of the wheel, which is mounted on an arbor, is brought into contact with the fixed stop A. The dial indicator C is then set at zero with the lever B in contact with the next tooth of the wheel. Successive readings are then taken between each tooth and its adjacent tooth, and variations in pitch are indicated on the dial. It will be noted that these readings give comparative errors only, but they can be reduced to give absolute errors by taking the algebraic sum of the dial readings once round the wheel, dividing this by the number of teeth in the wheel, and adding the result algebraically to the individual dial readings. A similar method is used for testing errors in the worm, but in this case the dial indicator is moved axially, from thread to thread, through a distance equal to the linear pitch. This distance is measured by slip gauges and a positive reading is, therefore, obtained immediately.

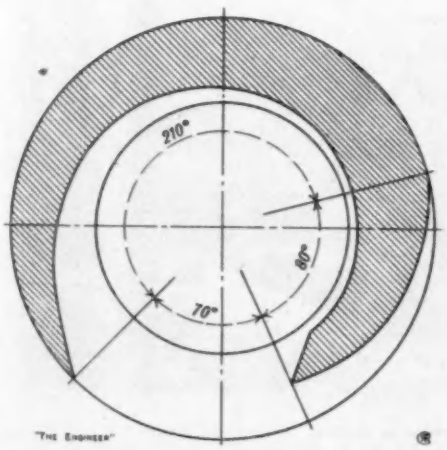


FIG. 12—THEORETICAL CONTACT DIAGRAM

Profile errors can be measured by a gauge applied to the worm threads, but because of the difficulty of measuring the wheel profile, the best method is to gauge the combined accuracy of both the worm and wheel profiles by observation of the "marking" obtained on the teeth and threads when meshed at the correct centres. This test is carried out by mounting the gears at correct centres on the fixture shown in Fig. 11. The worm threads are marked lightly with Prussian blue, and the effect of running the gears round by hand is to show very clearly on both worm and wheel where contact is taking place. Much more information is obtained from the marking on the worm than that on the wheel, and usually an examination of the worm contact is sufficient to show the position and approximate magnitude of any errors. In order to facilitate the inspection, a diagram is usually made to show the theoretical marking which should be obtained on the worm. A typical contact diagram used for comparison with the actual result is shown in Fig. 12.

The Kill van Kull Bridge, New York.

No. I.

IT is a noteworthy fact that two bridges, both of them of first rank in importance, should be under construction at the same time to form interstate links between New York and New Jersey. They are the great suspension bridge over the Hudson River, joining Fort Washington at the north end of Manhattan Island, with Fort Lee in New Jersey, and what is known as the Kill van Kull Bridge between Bayonne, New Jersey, and Port Richmond, Staten Island. We have dealt with four Progress Reports on the first-named bridge in our issues of April 20th, 1928, May 3rd, 1929, August 1st, 1930, and May 29th, 1931, and we give in what follows a description of the second bridge, which is remarkable in that it is of somewhat the same type, as, and just a little greater in span than the Sydney Harbour Bridge. Our information is obtained from two Progress Reports on the structure, the second of which is dated March last. Both the Reports, as were those on the Hudson River Bridge, are signed by Mr. O. H. Ammann, Chief Engineer of Bridges to the Port of New York Authority, and from them we quote largely verbatim.

The position of the Bridge is seen on the accompanying engraving, Fig. 1. The Kill van Kull is an important waterway, it being the main gateway to Newark Bay and the Arthur Kill, and it carries, annually, a greater tonnage than passes through the Suez Canal. The Bridge comprises a single steel arch over this piece of water, flanked on each side by steel plate girder span approaches, supported on concrete piers. The main structure is a two-hinged arch, which has a span of 1675ft. between the centres of the bearings of the arch shoes, or 1652ft. between the centres of the end pins. This span is nearly 700ft. longer than that of the famous Hell Gate Arch, and compares with that and other large arch spans as follows:—

	Length of span between centres of end pins.
Eads Bridge, St. Louis (opened 1874) ..	520ft.
Bridge over the Tyne (opened 1928)	531ft.
Niagara Bridge (opened 1898)	840ft.
Hell Gate Bridge, N.Y. (opened 1916) ..	977ft. 6in.
Sydney Harbour Bridge	1650ft.
Kill van Kull Bridge	1652ft. 1in.

The Port Richmond Approach is, approximately, 2900ft. in length, and the Bayonne approach, approximately, 3700ft., so that the total length of the Bridge, with its approaches, is well over 1½ miles. The roadway profile consists, principally, of straight 4 per cent. gradients, with connecting vertical curves at the end, and with a hyperbolic curve over the arch structure.

The arch is composed of two arch trusses, spaced 74ft. centre to centre, apart, with a rise of 274ft. from the centre of the bearing to the crown of the lower chord. Each truss has a depth of 37ft. 6in. at the crown, and the depth increases slightly towards the abutments, the panel curve of each chord being a true parabola. At the crown of each arch, the upper chord reaches a height of 327ft. above the water.

Because of the importance of the Kill van Kull as a waterway, special attention was paid in the design of the Bridge to adequate clearances. The arch abutments come well within the U.S. Pierhead lines, and the entire waterway is free of pier obstructions. There is a clearance of 150ft. above mean high water at the centre of the main span, under extreme conditions of full load on the bridge and lowest temperature. At other points the minimum

FIG. 1—POSITION OF KILL VAN KULL BRIDGE

clearances, under the same conditions, are as follows:—

143ft. 6in. at any point within the present 400ft. channel
140ft. " " " proposed 800ft. "
135ft. " " a channel 1000ft. wide.

These clearances are considered to be ample for navigation, and are from 15ft. to 20ft. in excess of those under the East River Bridges and many other bridges over navigable waterways.

THE ARCH AND FOUNDATIONS.

The arch design for the bridge was selected after an elaborate study and comparison with alternative designs and other types of bridge. During 1927, detailed design studies and estimates of cost were made for cantilever, suspension and arch types. It was early discovered that the cantilever design would be the most expensive of the three, and, since it was decided that it would also be esthetically inferior to an arch or suspension structure, it was eliminated from further consideration. The comparison in cost between a suspension design and an arch design was found to be somewhat closer, and consideration was given to the possibility of obtaining competitive tenders on the two designs; but, on going further into the matter, it was ascertained that, apart from the fact that a suspension bridge would be less rigid than an arch, it was estimated that a suspension bridge, comparable with an arch bridge for the same service, would cost from 1 million to 1 million and a-half more dollars than an arch, and the latter design was, therefore, adopted. Another consideration which influenced the choice was that the presence of bed rock near the surface, which afforded solid foundation to resist the arch thrust, was particularly suitable to the arch design at the position chosen for the bridge. The arch can deliver its thrust almost directly to solid rock, whereas the suspension type would have required massive anchorage piers to resist the cable pull. The arch abutments have, as a fact, been, for architectural reasons, designed to present a massive appearance, but they are of solid masonry only for sufficient height to support the arch shoes, while the upper portions

are hollow structures of comparatively inexpensive concrete construction with granite facing.

At both abutments, the bed rock consists of a dense, hard diabase, known as "Palisades trap," the top ledge of which is at shallow depths. On the Bayonne side the bed rock was found to be from 10ft. to 14ft.

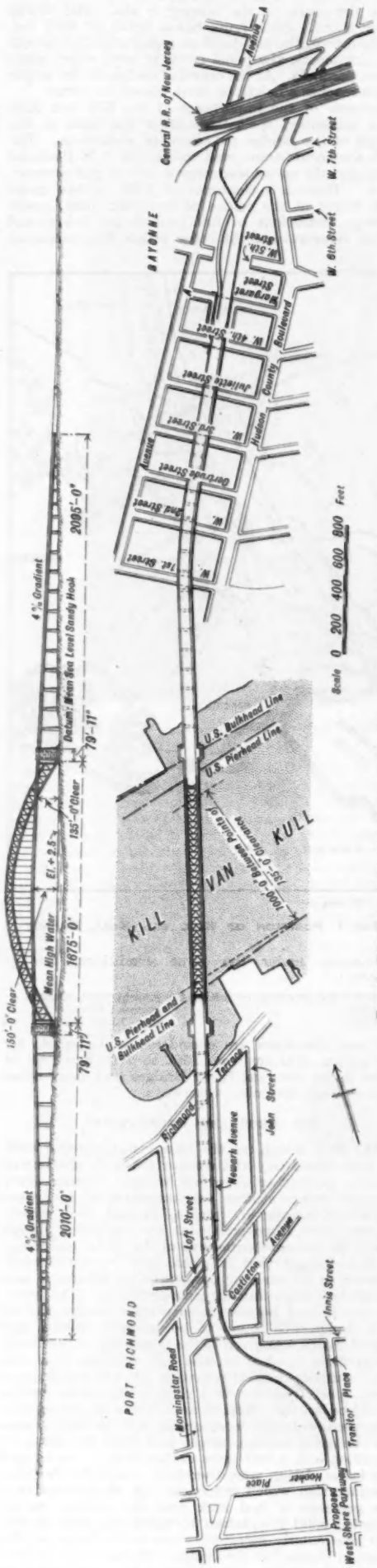


FIG. 2—PROFILE AND PLAN OF THE KILL VAN KULL BRIDGE

below mean low water, and the overburden to vary from nothing to about 5ft. in depth. On the Port Richmond side, the bed rock is from 18ft. to 25ft. below mean water level and the overburden was from 5ft. to 8ft. in depth. At both abutments the overburden consisted of silt and boulders. In the approaches on each side of the river, the bed rock was found to be of the same character as that at the abutment sites, but at depths varying from elevations +8 to −17 on the Port Richmond side, and from +3 to −10 on the Bayonne side. On each side the overburden was of clay, sand and boulders.

The construction of the foundations for the arch abutments presented no special difficulties. The two abutments are identical in plan, each measuring about 133ft. by 107ft. in extreme dimensions at the base. Both were constructed of concrete masonry, faced with granite from a level of 6ft. below mean low water. The foundation work was, in both cases, carried out inside a cofferdam, the walls of which were formed by double lines of steel sheet piling, the intervening space being filled with silt and sand. On the Bayonne side, the cofferdam measured 204ft. by 180ft. overall, the lines of sheeting being 10ft. apart. On the Port Richmond side, the cofferdam

FIG. 3—ARCH HINGE PIN

measured 214ft. by 190ft. overall, with the lines of sheeting 15ft. apart. The sheeting was from 18ft. to 23ft. in length for the Bayonne cofferdam, and from 28ft. to 30ft. in length for that on the Port Richmond side. The sheeting for both was 16in. by 33·3 lb. Lackawanna steel sheet piling. After the sheeting was driven, the two lines were connected by steel tie rods, and the space between the walls was then filled in.

On account of the shallow depth of the bed rock at the site of the Bayonne abutment, additional material had to be deposited there to provide sufficient cover to support the piles and sheeting when they were driven. In the Port Richmond cofferdam, many sections of the sheet piling came to rest upon boulders; but, in general, the sheeting was driven to refusal in hard pan. By constructing an embankment of overburden along the sheeting before the cofferdam was unwatered, and by carefully maintaining that embankment during the construction period, leaks were prevented, and no difficulty in keeping the cofferdam water-tight was experienced.

After the Port Richmond cofferdam was unwatered, the silt was cleaned off the rock ledge by a 2in. high-pressure water jet and by hand excavation, although, in some areas overlying the deeper parts of the bed rock, the gravel was so thoroughly compacted that percussion drills were required to loosen it. It was also necessary to blast off the top layer of rock over more than half of the foundation area, because a seam of clay was found in the rock. This clay seam started as a feather edge, to the east of and approximately parallel with, the axis of the bridge, and it extended in an inclined plane into the rock towards the west, to a maximum depth of about 8ft. below the original rock ledge.

On the Bayonne side, the depositing of additional cover over the rock and the placing of an embankment inside the cofferdam, sealed it completely. The surface of the bed rock was cleaned, almost entirely, by the use of high-pressure water jets, and the rock was found to be entirely free from seams and faults. Because the surface was relatively level, however, pits were blasted in the rock to provide satisfactory resistance to the horizontal thrust of the arch.

THE ABUTMENTS.

Since both the abutments were surrounded by water the Kill van Kull afforded the most convenient as well as the most economical means for the transportation of materials and the handling of the contractor's plant. Floating equipment was used throughout, as it gave easy access to all parts of the work and complete flexibility in adapting the plant to the changing constructional operations of pile-driving, excavation, concreting and the accurate setting of stonework and structural steel. Dredging was necessary from the channel in the River to the site of the Port Richmond abutment in order to provide the necessary depth of water for the plant equipment, but no other preparatory work was needed at the site.

Gravel, sand and cement were all delivered in bulk, the gravel and sand being carried in barges and the cement in covered canal boats. The vessels were towed alongside the concreting plant and the materials transferred directly into storage bins above the mixer. The bulk cement was lifted from the boat by ordinary "clam-shell" buckets, working through the hatches, and was weighed in a specially designed device, which was furnished with outlets to permit the air to escape as the cement flowed in from the storage bin, so as to prevent dispersion of the cement, and to facilitate the filling of the weighing bin. From the weighing device, the cement was delivered directly into the mixer. The gravel was measured by weight, and the sand by volume. The concreting plant was assembled on a barge, which was formerly a car float, and which measured 205ft. long by 32ft. wide. A single 150 H.P. boiler plant was provided on the barge for all the engines which, operated (*a*) a material handling hoist having a 75ft. boom and a three-drum hoisting engine; (*b*) a 2 cubic yard concrete mixer, and (*c*) a chuting system tower, 100ft. high, equipped with a 1 cubic yard hoisting skip, and a boom 115ft. long, to support the chutes. Charging bins and an inundator were arranged over the mixer.

Each abutment was constructed as two main units, divided by a construction joint 4ft. to 6ft. wide along the axis of the bridge. Each unit was concreted in successive sections, with shear keys perpendicular to the line of thrust of the arch, the volume in single sections varying from 240 to 450 cubic yards.

A special feature of the abutments is the provision

FIG. 4—BAYONNE ABUTMENT—STEEL ANCHOR FRAME AT SKEW-BACK

of structural steel frames for supporting the steel arch shoes at the skew-backs. These frames are 15ft. 2in. by 18ft. in plan, and they are embedded 11ft. into the concrete. They were erected in place as the construction proceeded, additional steel members being provided to assist in their erection, and the concrete being poured round them. The skew-back faces were finished 2½ft. away from the bearing planes for the arch shoes. After the shoes were erected on the frames and riveted to them, the spaces between the shoes and the abutments were filled in with concrete.

Tenders for the construction of the abutments were obtained in July, 1928. There were fifteen of them and the work was entrusted to H. P. Converse, of Boston, Mass., who sent in the lowest tender. Constructional work was begun on September 18th, 1928. The Port Richmond cofferdam was pumped dry on the November 24th following, and concreting was started on February 19th, 1929. The Bayonne cofferdam was pumped dry on January 22nd, 1929, and concreting was begun on May 18th following.

The concreting of the Port Richmond abutment was completed in May, 1929, and that of the Bayonne abutment in the following July.

Tenders for the supply and erection of the structural steel for the arch span and for the approaches were sent in in November, 1929. There were three of them, and the work was awarded to the American Bridge Company, which submitted the lowest tender.

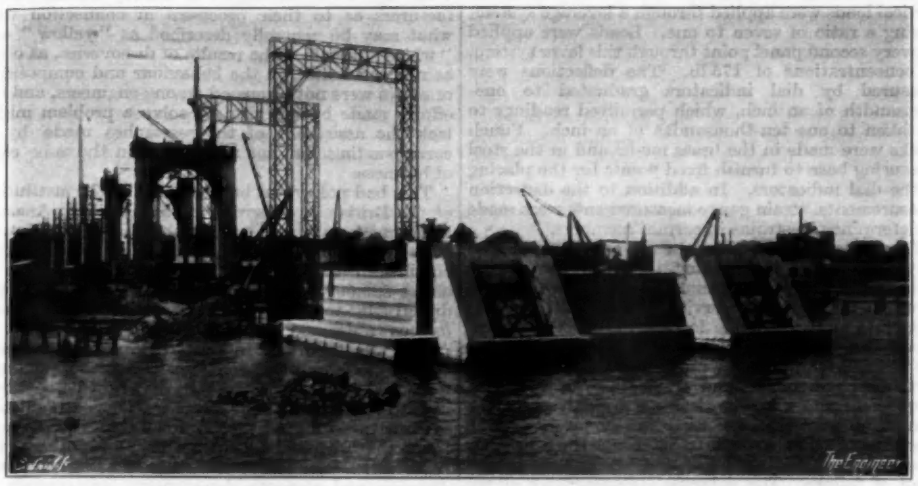


FIG. 5—PORT RICHMOND ABUTMENT READY FOR ERECTION OF ARCH

THE ARCH.

The arch span, as explained above, is a parabolic two-hinged steel structure. The bottom chord is the principal arch member, and, at the abutments, it supports the entire arch thrust. It is composed entirely of carbon-manganese steel, and has cross-sectional areas of 980 square inches at the abutments and of 580 square inches at the crown. The hinges are formed by pins 16in. in diameter, which bear upon heavy steel forgings, so as to ensure uniform bearing over the supporting structural steel webs. The arch shoes, upon which the lower pin bearings were erected, are of riveted structural steel. Each shoe is 10ft. high and 15ft. by 18ft. at the base and weighs about 120 tons, while each of the forged pin bearings weighs about 60 tons. The top chords of the trusses are of silicon steel, with cross sections varying from 272 square inches to 421·5 square inches, the maximum section having been determined by the erection stresses and being 38·5 square inches greater than that required for the arch alone. The web members of the trusses and the bracing between the trusses are of carbon steel. The floor beams and stringers which support the deck slabs are partly of silicon steel and partly of carbon steel.

The arch was designed to act as a three-hinged arch under the dead load of the trusses and the bracing between them, and as a two-hinged arch for the remaining dead load and the live load. In order to obtain the three-hinged condition, a temporary pin connection was made at one point on the lower chord of each truss to act as a hinge until the arch was swung free of the temporary supports. The arch design was based upon having that hinge at the crown of the arch. However, in consequence of the necessity to keep the navigation channel—which happens to be close to the Port Richmond shore—free of falsework, unsymmetrical erection was necessary, and the temporary hinge was, as will be explained later, made to come at a point 248ft. south of the crown of the arch.

The arch was erected by cantilevering from each side to the connecting point over the channel. Temporary steel piers or bents, made up largely of material destined, finally, for use in constructing the bridge deck and the approaches, were used to support the arch trusses at certain points as the erection proceeded. Four such bents were used for the south arm, and six for the north arm of the arch. Hydraulic jacks, erected on alternate bents, were employed to raise the arch from the preceding bent and then to lower it to full bearing on the succeeding bent, as the erection proceeded, each bent being wholly unloaded as soon as erection had advanced to the succeeding bent. The hydraulic jacks which were used by the contractor had actually been originally made for and used in the erection of the Hell Gate Bridge. Each had a capacity of more than 3500 tons. The south arm of the arch was erected to the connecting point over the channel, referred to above, before the erection of the north arm was begun, and the falsework bents, which were released from the former, were used again to support the latter.

A single traveller, which moved on rails along the upper chords of the trusses, was employed for the work of erection. The traveller consisted of a silicon steel frame supporting a derrick with a 70ft. boom, with petrol engines for operation. When the erection of the south arm to the connecting point was completed, the traveller was backed off to the abutment, where it was dismantled, taken across the waterway and reassembled on the north abutment for use in erecting the north arm. After the north arm had been erected and the hinge connection made to the south arm, the jacks at the remaining bent under each arm were lowered to swing the arch free of the two bents. It was then a three-hinged arch, with the third hinge at the fourteenth panel of the south arm. In order to establish the design condition of a hinge at the crown of the arch instead of at the fourteenth panel point, the jacks on the falsework bent beneath the south arm were raised again to lift the arch a definite amount, which was calculated as the amount needed to remove all stress from the closing chord connection. In that position the closing connection of the top chords between the two arms was riveted in place, and the jacks were then lowered to swing the arch free in its final two-hinged condition.

Rolling of the structural steel for the bridge was started in April, 1929, fabrication was begun in May, 1929, erection in the following September, and the south arm was completed in March, 1930. The arch span contains approximately 16,800 tons of steel.

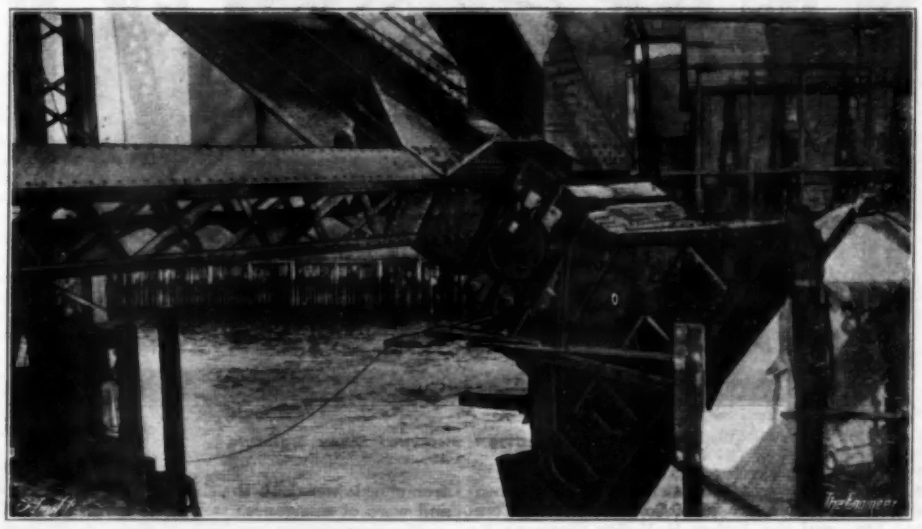
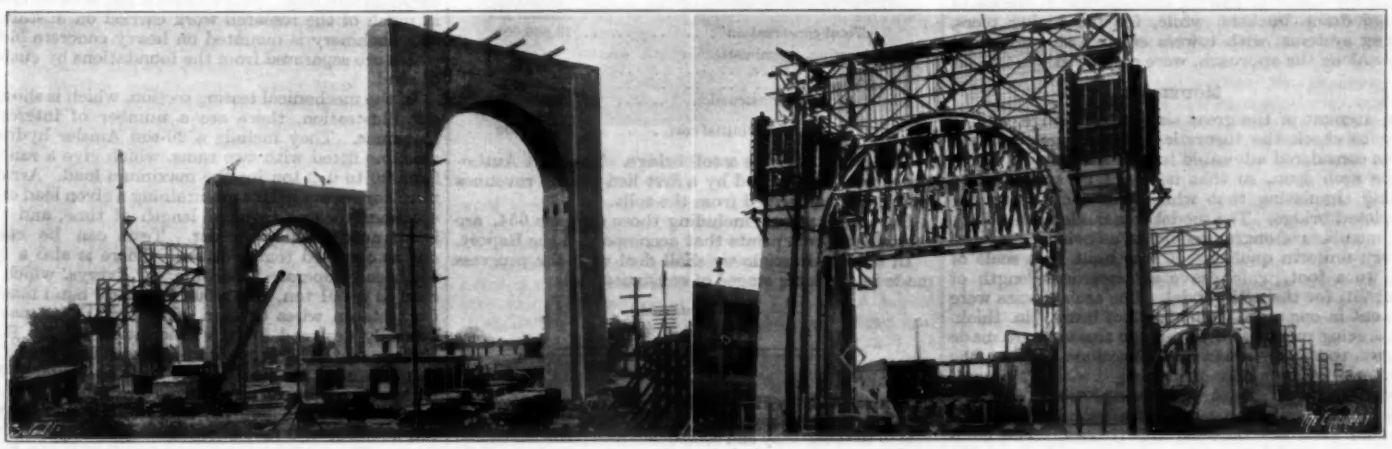


FIG. 6—ARCH HINGE AND SHOE, PORT RICHMOND ABUTMENT

THE APPROACHES.

A profile and plan of the bridge with its approaches are given in Fig. 2. It will be seen that the arch crosses the Kill van Kull channel at a considerable skew—58 deg., to be precise. The position chosen necessitated the use of a longer span than would have been necessary had the channel been crossed at right angles, but the Report explains that the direction decided upon involved the destruction of the least amount of taxable property, and is most convenient with respect to important street connections on both sides. The terminus of the approach on the Bayonne side is immediately south of the Central Railroad of New Jersey, between Avenue "A" and Hudson County Boulevard, with both of which streets the bridge roadway will connect directly. The Port Richmond terminus—or Plaza, as it is termed—is just south of Innis-street and east of Morningstar-road. The latter, together with Richmond-avenue and Ramono-boulevard—all of which streets the City of New York is planning to widen to 100ft.—



FIGS. 7 AND 8—CONSTRUCTION OF PORT RICHMOND AND BAYONNE APPROACH PIERS

will constitute a through artery from the bridge Plaza through Staten Island to the Outerbridge Crossing between Tottenville and Perth Amboy. It is also intended to supplement this thoroughfare with a parkway, 200ft. wide, situated near the westerly side of Staten Island, and extending from the Kill van Kull Bridge Plaza south to the Tottenville Plaza of the Outerbridge Crossing.

The approaches consist, as has been said, of a series of deck plate girder spans. The spans vary from 65ft. to 128ft. in length, and are simple spans, with the exception of one span, 183ft. long, which comprises the central portion of a three-span continuous girder. In all, there are about 9500 tons of steel in the approaches. The piers on which these spans are supported, are of reinforced concrete, and they vary in height from 20ft. to 110ft. above the surface of the ground. The lower piers consist, in general, of two independent hollow shafts, while the higher piers consist of two hollow shafts connected at the top by an arch. The principal reinforcement was a structural steel frame, composed of angles with bolted connections, embedded in each pier. These structural frames furnished means for holding the forms in place, as well as constituting rigid reinforcement for the concrete. In addition to the frames, "surface reinforcement" by steel rods was used near the external faces. For the higher piers the footings were taken down to the rock, but for the lower piers spread footings were employed where the overburden was of a solid character.

In order to provide plant flexibility for access to the piers over the length of each approach, the contractors—who were the P. T. Cox Contracting Company, Inc., and the Arthur McMullen Company for the Bayonne and Port Richmond approaches respectively—in each case used paving mixers for mixing the concrete. The aggregates were batched by weight at a central batching plant, and delivered to the work ready for being shot into the mixer. Travelling cranes were used for handling the excavation by "clam-shell" buckets, for the disposal of the excavated materials, for handling the forms and for erecting the structural steel. For the lower piers the cranes were used for placing the concrete by means of bottom dump buckets, while, for the higher piers, chuting systems, with towers erected at convenient points along the approach, were employed.

FIG. 9—ARCH ERECTION SHOWING SWAY BRACING

MODEL.

On account of the great size of the bridge, and in order to check the theoretical stress investigations, it was considered advisable to construct a test model of the arch span, so that it might be subjected to loading simulating that which will come upon the completed bridge. The model was made with all the arch members of engravers' brass, as being a material of very uniform quality. It was built to a scale of $\frac{1}{4}$in. to a foot, which gave a convenient length of about 9ft. for the arch model. The arch trusses were each cut in one piece from sheets of brass, $\frac{1}{4}$in. thick. The bracing members between the trusses were made of brass rods, $\frac{1}{4}$in. square. Connections between the members were made principally with "silver" solder, although gusset plate connections, fastened with soft solder, were used for the connections of the diagonal members between the trusses. The completed arch model was set on heavy steel shoes, the connections between the arch rib and each shoe being made with a turned steel bolt, $\frac{1}{4}$in. diameter, to represent the arch hinge. The shoes were mounted rigidly on a timber framework, to which they were secured by two 8in. channels to furnish a base for measurements.

The experimental tests made on this model consisted in the application of vertical and horizontal loads at various panel points and the observation, by sensitive instruments, of the deflections of the model and the strains in its members. A complete mathematical analysis for the arch model was also made, and the observed deflections compared with those computed. In order not to overload the floor of the building in which the tests were made, the vertical loads were applied through a leverage system, having a ratio of seven to one. Loads were applied at every second panel point through this lever system, in concentrations of 175 lb. The deflections were measured by dial indicators graduated to one-thousandth of an inch, which permitted readings to be taken to one ten-thousandth of an inch. Punch marks were made in the brass model and in the steel measuring base to furnish fixed points for the placing of the dial indicators. In addition to the deflection measurements, strain gauge measurements were made to determine the strains in certain members.

The Report states that the observations proved very satisfactory in checking the behaviour of the arch under conditions simulating those which will occur on the bridge in service. The model analysis was particularly valuable in determining the strains in certain members, such as the sway bracing between the trusses, for which the mathematical analysis was particularly involved and intricate. In order to supplement the mathematical stress analyses of the heavy built-up sections used in the arch chords, special tests were also made to determine the behaviour of such members in compression under load to the point of failure. The columns representative of the arch chords were half the size of the actual members, and were of manganese steel. The tests were made in the compression machine of the U.S. Bureau of Standards at Washington. Failure having occurred by buckling of the cover plates, the chords were redesigned with thicker cover plates.

COST.

The estimated cost of the bridge is 16,000,000 dollars, made up as follows:—

	Dollars.
Main bridge—construction	6,640,000
Approaches, construction	4,010,000
Total construction	10,650,000
Engineering, administration and contingencies	1,610,000
Real estate	2,400,000
Interest during construction	1,340,000
Total estimated initial cost	16,000,000

The bridge is to be a toll bridge. The Port Authority bonds are secured by a first lien on the revenues which will be derived from the tolls.

Our illustrations, including those on page 654, are reproduced from prints that accompanied the Report.

In a second article we shall deal with the progress made in the later stages of construction.

(To be continued.)

IT is reported by H.M. Trade Commissioner at Montreal that a firm in Sydney, Nova Scotia, has drawn his attention to the long delay and consequent inconvenience caused by letters and parcels being addressed to Sydney, N.S., instead of in full to Sydney, Nova Scotia. This has resulted in some instances in mail being sent to Sydney, New South Wales, in error. While special instructions have been issued by the Post Office to safeguard against mail for Sydney, Nova Scotia, being mis-sent to Sydney, New South Wales, United Kingdom firms are advised to take the precaution of addressing mail in full, "Nova Scotia" or "New South Wales," and not "N.S." or "N.S.W."

Non-Ferrous Research.

RESEARCH into the behaviour of non-ferrous metals from a commercial point of view, has been, in the past, of a rather disconnected nature, and there was some years ago a certain degree of secrecy among manufacturers as to their processes in connection with what may be generally described as "yellow" and "white" metals. The results of discoveries, as often as not accidental, in the behaviour and composition of alloys were not discussed among engineers, and the efforts made by one firm to solve a problem might lack the assistance of the researches made by a corresponding, but not allied, firm in the same class of business.

This bad policy was broken down by the institution of the British Non-ferrous Metals Research Association some ten years ago under the *ægis* of the Department of Scientific and Industrial Research in modest circumstances. It now has an annual income of about £25,000, of which some £16,000 is subscribed directly by manufacturers connected with the non-ferrous trades and the remainder by the Treasury.

The growth in the interest of the industries concerned has been consistent, ever since the inauguration of the idea, and the time has now come when, instead of entrusting investigations to existing institutions, such as the National Physical Laboratory, the Birmingham University and others, the Association is in a position to have its own headquarters and research departments immediately in contact with one another.

Such a scheme has been realised in the new Regnart Buildings which were opened by Lord Rutherford on June 8th. The buildings are near Euston Station, and are consequently quite convenient to several of the main line termini of London, and although they are in a rather obscure *cul de sac*, they can be readily found by means of a sketch map issued by the Association.

It is only natural that the appearance of the laboratories is at present rather that of a museum, as very little productive work has been done there yet; but a considerable amount of plant and apparatus has been installed, and on the occasion of a recent visit we saw a great number of exhibits concerning work already carried out elsewhere which indicated the intentions of the directorate in the way of research in the new establishment.

The building has four floors, each of about 2600 square feet area, of which the basement is devoted to the heavier machinery; we give an illustration of part of this floor. On the ground floor are the general offices, library, &c., whilst the second floor is devoted to what is known as the Development Department, which is concerned with the commercial application of the results obtained in the research laboratories on the next floor.

In the basement there is an electricity supply capable of delivering up to 140 kW. There is direct current of 220 volts and 440 volts, and alternating current can be produced by a motor alternator at frequencies ranging from 13 to 53 at any voltage up to 500 per phase. The machine, which was manufactured by Crompton-Parkinson, Ltd., runs at any speed from 400 to 1600 revolutions per minute, and is so arranged that it may be coupled with a high-frequency alternator of 100 kW capacity in the future. In the meantime a small high-frequency furnace installation of 35 kVA has been provided for experimental work.

There is a workshop for preparing specimens and making research apparatus, which is equipped with two lathes, a milling machine, a drilling machine, a band saw, a hack saw, and some grinders. An interesting feature about this shop is the care which has been exercised to prevent vibration being transmitted to the main building. Such vibration might cause trouble in much of the research work carried on upstairs, so the machinery is mounted on heavy concrete blocks, which are separated from the foundations by cushions of sand.

In the mechanical testing section, which is shown in our illustration, there are a number of interesting machines. They include a 20-ton Amsler hydraulic machine fitted with two rams, which give a range of from 20 to 0·2 ton for the maximum load. Arrangements are provided for maintaining a given load on the specimen for any required length of time, and there is an autographic recorder. Tests can be carried out at elevated temperatures. There is also a 5-ton electrically operated machine, by Averys, which will read to 0·001 ton, and a 500 lb. Avery hand machine for tests on wires or thin strip metal. A machine specially designed for the Association by Mr. R. W. Bailey, of the Metropolitan-Vickers Electrical Company, is used for slow tensile tests at elevated temperatures. Two rates of strain are obtainable, viz., 0·001in. and 0·025in. per minute, while creep tests can be made at a rate of strain of 10^{-5}in. per hour, or more. The machine is so equipped that it can be left to continue a test during the night. There is a Vickers diamond hardness tester, a Shore scleroscope, an Izod machine, by Averys, and two machines for cupping tests on sheet metal. A small slow bend testing machine for strip metal has been presented by the Incandescent Heat Company. Partitioned off in the basement there is a small casting shop, which is equipped with a gas-fired furnace and an electric

resistor furnace, by the Electric Resistance Furnace Company. Casts up to 120 lb. of copper can be made. There is also a Durville casting machine, by means of which the contents of a crucible can be poured into a mould gradually and without turbulence, so as to prevent the inclusion of slag or dross in the ingot.

On the ground floor there are the offices, council room and library, which contains some 8400 books and pamphlets. On the floor above there is the development department, which is rather in the nature of an exhibition illustrating the results which have been obtained in researches which have been carried out by the Association. Finally, on the second floor, there is the general research laboratory. It is well equipped with benches having gas, water and electricity services, a dark room, rooms for micro-

MECHANICAL TESTING SECTION AT REGNART BUILDINGS

scopes, balances, &c., and offices. Among the equipment in the laboratory there may be mentioned a thermo-couple potentiometer, by H. Tinsley, which reads to one microvolt; two spectrographs, by Adam Hilger; a special apparatus, designed by Dr. J. C. Hudson, for research in the atmospheric corrosion of metals, and a Kelvin double bridge for measuring electrical resistivities.

In the microscope room there is the Vickers projection microscope, of which we give an illustration. This instrument was designed by Mr. R. L. Smith, of Vickers, Ltd., and made at the Vickers-Armstrong Works at Erith. It has many novel features and is characterised by extreme massiveness, yet compactness, so that trouble due to vibration is completely overcome. The microscope is mounted upon a heavy cast iron case, and the image of the lower face of the specimen is reflected by a rustless steel mirror on to the camera screen. The mirror and camera screen are linked together and controlled by a conveniently situated handle, by which they are moved in unison to give the required camera extension. Two lamps, a clockwork arc lamp and a pointolite lamp, are provided, and are carried by a swivel support at the end of the optical bench, so that the change from one type of illumination to the other can be made instantaneously, while the optical bench as a whole, with lamps, water trough, condenser, &c., can be raised or lowered by a rack and pinion motion. On one side of the camera there is a comparison chamber provided with a special lamp for the comparison of transparencies of standard structures with the image on the camera screen.

The microscope objectives are mounted in magnetic chucks, which enable them to be readily changed without the tedious process of meshing fine threads. The objectives and eye-pieces for this equipment are also of British manufacture, and were specially selected for the Association by the kindness of Sir Herbert Jackson and the British Scientific Instrument Research Association. A series of lenses, also of British make, is provided for macro work. The microscope with the optical equipment which has been chosen is available for use at magnifications ranging from 3 diameters to 2500 diameters.

We have given a brief description of the equipment as it stands at present, but it may be mentioned that the Association hopes, through the generosity of individual donors, or by the extension of the funds available, to add other apparatus, such as:—Larger high-frequency electric furnace equipment, including a H.F. alternator, provision for the driving of which has already been made; an X-ray installation, particularly for the extension of the Association's researches on corrosion protective films and oxide scales; fatigue testing machines, especially a Haigh alternating stress machine, which had to be rented for the Woolwich research on lead alloys, in which this test played such an important part; special equipment for bearing metals tests; an abrasion testing machine; small experimental rolls and wire-drawing equipment; an arc welding plant for the extension of research on copper and non-ferrous alloys welding; refrigerating and small liquid air plant for work at low temperatures; and vacuum melting and casting equipment.

The activities of the Association are perhaps best exemplified on the first floor, which, as already noted is at present more or less of an exhibition, although it is intended that it should be developed into a more active means of collaboration between the purely research side of the Association and that more intimately connected with the commercial affairs of the subscribers. In it we found some most interesting specimens showing work already done and some most enthusiastic workers.

Take, for instance, the case of copper fire-boxes for locomotives. There has been, admittedly, trouble through the wastage of the plates in the vicinity of the stays. The matter was referred to the Association and it was discovered that the trouble was caused by minute leakage of the boiler water past the screw threads of the stays. These threads could not be properly and permanently staunched, and the Association set out to find the reason why it could not be done. After painstaking investigation it was found that the trouble was not caused, as might at first be thought, by the longitudinal stretching of the stays under the stress of the boiler pressure, but by the repeated thermal expansion and contraction in a transverse direction of the metal, which was not entirely recuperative. Some experiments were made, and it was discovered that by the addition of only 0·05 per cent. of silver to the copper it could be given

VICKERS PROJECTION MICROSCOPE

such elastic properties that the leakage round the stays, and consequently the wastage of the plates, was completely removed.

Another matter appealing directly to power engineers is the investigation which has been carried out into the corrosion of condenser tubes, and herein there is involved one of the most fascinating and promising explorations of the metallurgist. It revolves round the formation on a metal of a "self-healing" coating much as on a wound in the flesh of a living animal, which will protect the underlying material from further damage. The researches of the Association have shown that such an ideal is within sight at least in the case of some metals and alloys.

Lead has received a considerable amount of attention by the Association, especially in connection with the sheathing of electric cables and the provision of water piping of more moderate weight than that of the past. In these cases, again, elasticity has proved to be a crucial factor, and it has been found that small additions of other metals such as cadmium, antimony and tin, have so improved the qualities of the metal that it could be reduced by at least one-third in weight without impairing its strength. This investigation has not only reduced the massiveness of the lead water pipes which used to be used for domestic services, but has also conduced towards the continuity of service of submarine cables, which may be festooned over heights in the bottom of the ocean and consequently subjected to fatigue stresses through oscillations by tides and waves.

The support of such objects as superheater elements calls for a material of unusual qualities—resistant to the corrosive effects of heat and the maintenance of a reasonable strength at high temperatures—and here again the efforts of the Association have been successful. The best material for the purpose known at the outset of the investigation was a nickel-chromium alloy having a creep strength of 1·9 tons per square inch at 800 deg. Cent.; but there has now been found an alloy of this character with a corresponding strength of 5 tons per square inch. The casting of aluminium and alloys which tend to produce a skin that may spoil the homogeneity of the casting has been studied and a process of eliminating the trouble discovered, while the technique of galvanising has been investigated.

It is noteworthy in connection with all these matters that the Association's investigators appear to be fully cognisant of all recent practice in their special branches, and are quite able to discuss technical matters with those in charge of productive work, and that there is a general atmosphere of usefulness about the institution.

Obituary.

ROBERT BRUCE.

ENGINEERS all over the country, particularly those associated with marine work, will hear with regret of the death of one who, for many years, was known and liked by everyone in the profession. Robert Bruce belonged to a generation which had different characteristics from those of the present. He had not the "advantages" of a technical education; he entered business when he was but a lad; he completed his apprenticeship when young men of to-day are thinking of beginning theirs, and he became his own master at an age, which, in these years of grace, is never trusted with responsibilities. It may be that the new method has merits which, in the mass, make it better than the old, but when we look back upon the lives of the older engineers who had to win their way against difficulties which have been removed for the present generation, we are obliged to admit that the old plan had either the power of making men or the power of sorting out from the average those who had the qualities that lead to success.

Robert Bruce was born on May 5th, 1854, in London, and when only fifteen was placed in the office of the late Mr. Alexander Morton, of Glasgow, the inventor of the ejector condenser. During the term of his employment with Mr. Morton he was so fortunate as to come into contact with many eminent men engaged in the litigation arising from the infringement of Morton's patent, among these being Professor Sir William Thomson—afterward Lord Kelvin—his brother, Professor James Thomson; Mr. Frederick Bramwell—later Sir Frederick Bramwell—Professor W. J. M. Rankine, Dr. Kirk, Mr. James R. Napier, and Mr. William Hulse, of Manchester. He took particular pleasure in recalling the circumstance that his extreme youth served the purpose of Morton's counsel, who had intended to put him in the witness box to rebut the contention that the specification could not be understood by the ordinary mechanic. The case collapsed before he was called on, and the sum of one guinea handed him on that occasion was his first professional fee.

On leaving Mr. Morton's office, Mr. Bruce served an apprenticeship in the marine engineering works of the late Mr. James Howden, where he acquired his early practical experience in the construction of engines and boilers. Completing this part of his training, he engaged, on his own account, as a contractor for engineering work, particularly the removal and re-erection of machinery, and the drainage of excavations, in which his special knowledge, acquired under Mr. Morton, proved helpful. An attack of typhoid fever contracted by drinking contaminated water terminated this phase of activity, and when he recovered he rejoined Mr. Morton for some years prior to proceeding, in 1889, to London, where he opened a small office in Bishopsgate-street. It was very shortly after his arrival in London that he became associated, once more, with the late Mr. James Howden, who was then commencing to promote the use of his system of forced draught, to the introduction of which Mr. Bruce, for a number of years, devoted all his time. This work brought him into contact with marine engineers in all countries and covered, roughly, the period extending from the introduction of the triple-expansion engine to the full development of the marine steam turbine.

In 1906 Mr. Bruce resumed consultative work and founded the firm of Messrs. Robert Bruce and Sons,

of which he remained senior partner until his death, on June 2nd, in his seventy-eighth year.

Mr. Bruce had a remarkably retentive memory and could chat very entertainingly for hours about the people he had met and the events with which he had been concerned in his long life. We are glad to hear from his son, Mr. A. K. Bruce, that he left behind him some memoirs, and trust that they may see the light of day, for he was a living history of marine engineering during a period of the greatest interest.

Plate and Girder Drilling with Modern Drilling Machines.

By G. VARLEY, M.Sc., A.M. Inst. C.E., M.I. Mech. E., A.M.I.E.E.

THE fast penetration speeds which modern twist drills will stand under workshop conditions accentuate the importance of consideration for the percentage unproductive time of drilling machines. This can be divided into two factors :—

(*a*) The ratio of the "between holes" time to the total time per hole.

(*b*) The ratio of machine idle time to the working day.

The first factor is in the hands of the maker of the drilling machine ; the second is a matter of shop organisation and lay-out and concerns the reduction of waiting time whilst jobs are changed, thoroughness of preparation of work for drilling—*i.e.*, marking off, centre popping and batching—adequate support of work against thrust of the drill—particularly batched thin plates—quick service of re-ground drills, &c.

These notes are largely directed to an extension of the first factor, "between holes" time, and to the results achieved in its reduction in the latest designs of girder drilling machines, with spindle motor on the slide and readily accessible controls. "Between holes" time includes :—

(1) Movement of slide along arm.
(2) Circular movement of arm.
(3) Feeding down of barrel and spindle with hand wheel.
(4) Application of self-acting feed.
(5) Locking of arm on pillar.
(6) Locking of slide on arm.
(7) At conclusion of hole, removal of self-acting feed.
(8) Withdrawal of drill from hole ready to re-start cycle.

In the effort to reduce the total of time spent on the above movements and so increase the productivity of the machine, two general avenues of approach are obviously available, namely :—

(*a*) Each necessary motion should be made by the operator with a minimum effort.

(*b*) Wherever possible, one motion should be made to carry out more than one of the eight steps outlined above.

Facility and ease of movement is secured in the latest designs of machines by mounting the slide on four rollers carried on ball bearings, readily adjustable to secure a free moving slide without shake on the ways of the arm ; free swing of the arm on the pillar is obtained by the use of ball-bearing mounted rollers at the base and a double-purpose double-row ball bearings at the top taking the downward weight of arm and slide.

Additionally, reduction in the number of movements has been secured by combining the two locking operations (5) and (6) into one mechanism, by combining the motion of feeding down of the barrel (3) with the application of self-acting feed (4) as one and the same movement ; the aforementioned freedom of slide and arm movement is such that the two motions of movement along arm (1) and circular movement of arm (2) can be made with the one effort ; interruption of self-acting feed (7) and drill withdrawal (8) are now made with the one motion of the large hand wheel.

Hence the "between holes" time in drilling a series of holes of one diameter has been reduced in these machines to four movements for the eight functions listed above ; a further available improvement is the automatic turning on of a jet of cutting compound immediately the self-acting feed is applied (4) and shutting off this supply by action of withdrawal of the drill (8) ; this is again combined into the motion of the large hand wheel.

When the larger question of drilling holes of varying diameters is considered, the above principles have again been made the basis of the design of these machines ; all controls for operating the machine have been placed accessibly on the slide ; one lever only is used for speed changes, one lever only for feed changes ; drills can be automatically ejected from the spindle by the motion of the large hand wheel for withdrawing the drill from the hole ; the spindle motor started and stopped—and in machines fitted for tapping, reversed—by switch or push button mounted on the slide.

The following data giving the particulars of performance of these machines have been collected and are compared with similar figures for the older designs of girder machines which have been standard machines for structural work for years. Table I. gives particulars for the new machines, and from this table it is seen that the "between holes" time of drilling cycle has been reduced to between four and five seconds per hole. The effects of shop organisation or the daily efficiency is shown by the data of line 5 of Table I., giving the output for a 7½ hours' day from six machines engaged on the job for which line 3 is a spot observation of one hour on one machine during which the job—a five-ply batch of ¼in. plates for tank work—was not changed. This shows the overall efficiency to be approximately 72 per cent.

TABLE I.—*New Type Machines with Motor on Slide.*

Line.	Dia. of hole drilled, inches.	Plate thickness, inches.	Drill speed, r.p.m.	Feed cuts per inch.	Number of holes drilled.	Time in seconds. Total.	Net pen. time allowing for point of drill.	Difference "between holes" time.	"Between holes" time per hole.	Material drilled.	Remarks.
1	13/16	¼	343	58	28	330	207	123	4·4	Mild steel, 30 tons per per sq. in.	Single plate drilled to centre pops.
2	17/16	¼	450	80	275	3600	2150	1450	5·3	Ditto	Angle bars, 3½in. by 3½in. by ¼in., drilled to centre pops.
3	11/16	5-ply, 0·56–2·8	370	87	75	3600	3240	360	4·8	Ditto	5-ply of ¼in. plates, batched top plate centre popped.
4	13/16	4-ply, 2	380	58	10	240	204	36	3·6	Ditto	4-ply of ½in. plates, batched top plates centre popped.
5	13/16	5-ply, 2·8	370	87	2400	6 machines for 7½ hrs.	Overall efficiency $= \frac{2400}{6 \times 7\frac{1}{2} \times 75} = 71 \cdot 5$ per cent.				

Table II. gives results of performance with old type girder drills of the bogie type ; from this table it is seen that the "between holes" time averaged about eleven seconds per cycle. As showing the effects of shop organisation on weekly efficiency, Table III. gives the weekly average output for twenty machines for sixteen consecutive weeks from which it will be seen that the average earnings, per spindle were 1s. 1½d. per hour, against a possible hourly figure from Table II. of 1s. 3½d., showing an overall efficiency of 88 per cent.; this is an improvement on the case given in Table I., probably due to the greater ease of handling single plates against batched plates of medium thickness, which entail a lot of lost time in putting in bolts to prevent flexure—or "book-leafing"—of the plates under drill thrust.

There is one other marked improvement in the new design machines—power consumption. By placing the motor on the slide and using case-hardened and ground alloy steel gears, ball bearings to all shafts and starting and stopping the spindle by starting and stopping the motor, a minimum power is lost in friction and the motor does no idle running with spindle disconnected, as frequently happened with careless operation with the other types of machines.

TABLE II.—*Old Type Girder Machines, Motor on End of Arm.*

Line.	Dia. of hole drilled, inches.	Plate thickness, inches.	Drill speed, r.p.m.	Feed cuts per inch.	Number of holes drilled.	Time in seconds. Total time.	Net pen. time incl. for point of drill.	Diff. "between holes" time.	"Between holes" time per hole.	Material drilled.	Piecework price per 100 holes.	Max. rate of earnings per hour at this observation.
1	11/16	2-ply, ⅞ —1⅛	265	59	19	529	388	141	7·4	High tensile steel plates 37 tons per sq. in.	s. d. 1 0½	s. d. 1 4½
2	1 1/16	11/16	383	80	20	482	250	232	11·6	Ditto	0 10½	1 3½
3	Ditto	Ditto	Ditto	Ditto	20	430	250	180	9·0	Ditto	Ditto	1 5½
4	Ditto	Ditto	Ditto	Ditto	42	1022	525	497	11·8	Ditto	Ditto	1 3½
5	11/16	11/16	383	80	38	903	440	463	12·2	Ditto	0 9½	1 2½
6	11/16	11/16	383	80	20	521	232	289	14·4	Ditto	0 9½	1 1½
7	1 1/16	1	400	100	100	3600	2280	1320	13·2	Ditto	1 1½	1 1½
8	1 1/16	1	320	80	37	1160	842	318	8·6	Ditto	1 1½	1 3½
									Av. 11·0			1 3½

TABLE III.—*Weekly Output from Twenty Machines of Table II.*

Week No.	Number of machine hours per week.	Average number of machines in use.	Number of holes drilled.	Average number of holes drilled per spindle per hour.	Average earnings per hour per spindle.
					s. d.
1	564	12	77,830	138	1 1½
2	752	16	136,100	181	1 4½
3	752	16	81,220	108	0 11½
4	893	19	92,870	104	0 11½
5	987	21	118,200	120	1 0½
6	940	20	117,700	126	1 1½
7	987	21	104,600	106	1 0½
8	1081	23	154,600	143	1 0½
9	846	18	96,400	114	1 0½
10	846	18	95,600	133	1 1½
11	893	19	100,000	112	1 0½
12	893	19	101,000	114	1 0½
13	799	17	83,100	104	1 2½
14	564	12	65,400	116	1 3½
15	564	12	77,300	137	1 3½
16	611	13	61,700	101	1 2½
Average	811	—	97,730	121	1 1½*

* Average hourly earnings for week.

Holes varied from 11/16in. to 1 1/16in. through plates of high-tensile steel—37 tons per square inch—of thickness varying from ⅞in. to 1in., drilled singly.

The difference is quite appreciable, as the following data show :—

New Machines.—Three speeds, three feeds, 5 H.P. motor on slide, drilling 13/16in. holes through ¼in. plates, 400 r.p.m. of drill, 58 cwt. Number of holes per 8½-hour day, 1730 ; electrical units used, 13·9 ; units per 1000 holes, 8·0.

Old Type Girder.—Bottom driven by 8 H.P. motor, drilling ¾in. holes, ⅞in. plates, 370 r.p.m. of drill, 80 cwt. Number of holes per day, 1060 ; units used, 16·8 ; units per 1000 holes, 15·8.

Summary.—By attention to the factors controlling "between holes" time it is possible with the new type machines to secure :—

(1) A reduction of "between holes" time to five seconds, or less than half the previous figure.

(2) A reduction of power consumption to half the previous figure per 1000 holes drilled.

(3) Advantage of the maximum possible penetrations of the newest high-speed twist drills, which, combined with (1), gives an increase in daily output of more than 60 per cent.

SIXTY YEARS AGO.

WE reverted to the question of river pollution in our issue of June 16th, 1871. The occasion was a discussion, in a leading article, of the fact that, in the preceding week, the Metropolitan Board of Works had decided to petition against the Metropolis Water (No. 2) Bill. Exactly in what connection is not quite clear—for the principal object of that Bill was to introduce the constant supply of water—but we again referred to the application of the Richmond Vestry for permission to continue to discharge sewage into the river Thames for a further period of three years. The Richmond Bill had been passed by the House of Commons, but we expressed the hope that the Thames Conservators would strenuously oppose the measure in the Upper House. We pointed out that the onus of preventing the discharge of obnoxious matters into the river lay on the Thames Conservators, to whom the Water Companies paid, annually, a sum of upwards of £5000 on the understanding that they would carry out their powers for the preservation of the stream. We remarked that it was true that the Richmond outfall was below the lowest point at which water was drawn from the Thames to supply consumers, but, we continued, "if Richmond can gain the protection of Parliament in polluting the stream, and defying the Conservators, why not other towns ? At all events, other towns will expect to gain such a privilege, and will be the less disposed to set about the adoption of a proper remedy." In any case, we were at a loss to understand why the power of controlling the discharges into the river should be taken out of the hands of the Conservators, even for the period of three years. We then went on to refer to the treatment of sewage as evolved in the laboratory experiments of Dr. Frankland, which the Rivers Pollution Commission had described as "a system of intermittent filtration." It was explained that, in accordance with his proposed method of treatment, "three acres of a porous medium, 6ft. deep, are sufficient . . . for purifying the sewage of a town with a population of 10,000 persons." It was intimated, however, that some previous treatment of the sewage, in the shape of precipitation, might be needed "in order to prevent the filtering area from becoming itself a nuisance." That, we argued, opened the door for a certain amount of chemical treatment, and it might be suggested that, even in the case of sewage irrigation, there was room for something of the kind. The Commissioners might be said to believe in the commercial value as well as the agricultural utility of town sewage, but we were not sure that chemistry, as generally expounded, fully or correctly explained the operation of manurial elements, and added that "there is at least the authority of Liebig for believing that the ammonia standard is not the test of the value of manure." We concluded by saying that we might in time be privileged to see more clearly than ever how possible it was to purify our towns without polluting our rivers—"The more we advance in this direction," we said, "the less will be the difficulty of the water supply."

IT is proposed by the Federal Ministry of New South Wales that a sum of at least £200,000 should be expended on investigating the possibilities of the oil shale deposits of that country.

Railway and Road Matters.

THE acquittal of driver Eskdale on the charge of manslaughter, arising out of the Carlisle fatal derailment of January 3rd, for which he stood his trial at the Cumberland Assizes on June 1st–3rd, leaves undisturbed the record that no British railway servants has been convicted for that offence since the signalman concerned in the Quintinshill disaster of May, 1915.

THE Railway Rates Tribunal has authorised the London and North-Eastern Railway, as an experiment, to charge for traffic between London—including the docks—and Chelmsford, Colchester and Ipswich at the weight per wagon, irrespective of the nature of the contents. There are to be three series of rates—for 2 tons, 4 tons, and 6 tons. This is a very revolutionary change, as rates hitherto have been based on the value of the consignment; hence the old phrase "what the traffic will bear."

WE mentioned in this column of our issue of May 22nd how, in the aggregate, 2340 minutes—since increased to 2760 minutes—were being saved daily on the Great Western by the quickening of local and semi-fast trains. It is now announced that the London, Midland and Scottish Company's programme effects a saving of 2552 minutes. On the other hand, the London and North-Eastern must be given credit for making these economies, in the North-Eastern area at all events, during 1928 and 1929, and, moreover, saving 4000 minutes in that one area.

THE construction, for the second stage of the British Aluminium Company's Lochaber power scheme, of an aqueduct in tunnel between Loch Laggan and Loch Treig and a dam at the northern end of the latter to allow it to be raised by a height of 36ft., will necessitate the diversion to the east, for a distance of 1½ miles, of the West Highland Railway of the London and North-Eastern Railway, at a point at the north end of Loch Treig and just south of Tulloch Station. The railway has to be raised to a maximum of 34ft. above its present level, which will involve the construction of a tunnel 150 yards long and the excavation of 88,000 cubic yards of material.

IN this column of our issue of October 31st last we mentioned that, despite the fact that the second Automatic Train Control Committee had not reported, the Great Western was about to extend its automatic train control system—then already in use from London to Swindon, Oxford and High Wycombe—from Reading to Plymouth, Swindon to Taunton, Oxford to Banbury, High Wycombe to Wolverhampton, Swindon to Swansea, and Westbury to Weymouth. The additions necessitated the equipment of 1758 track miles and some 2000 locomotives. It is now announced that the lines from Reading to Plymouth and from Swindon to Taunton are completed and that the remainder will be done by the end of the year.

AN incident of interest to many of our readers was recorded in *The Times* of June 4th. It related that one of the new "Prairie" type locomotives on the Romney, Hythe and Dymchurch Railway became detached from the train and travelled at full speed for over a mile before it was pulled up by becoming derailed. The ten coaches, all filled with passengers, were stopped within a few yards. The incident is, as we have said, of interest; that is, mainly because the railway is of 15in. gauge; and, secondarily, because the separation of the coupling between the engine and the first vehicle would automatically cause the vacuum brake to be applied on the coaches and so stop them. Why the same thing did not happen to the engine and that it should run for a mile out of control is, however, not related.

FOLLOWING the centenary of the opening of the Liverpool and Manchester Railway last September, there will, in due course, be similar anniversaries of other openings. It is, for instance, one hundred years on the 13th instant since the Bolton and Leigh and the Leigh and Kenyon branches of the Liverpool and Manchester were opened. The former was actually sanctioned in 1825 and therefore before the Liverpool and Manchester was authorised, and was to join the Manchester, Bolton and Bury Canal at Bolton with the Leeds and Liverpool Canal at Leigh. When the Liverpool and Manchester took shape there was a desire to join Bolton to the new railway. That necessitated a railway, 2¼ miles long, to join Leigh to Kenyon, and that was sanctioned in 1829. There were some very steep gradients on these lines; on the Chequerbent bank it is 1 in 30 for 1579 yards.

AS part of that company's programme for converting double lines of railway into single tracks of which no less than 220 miles have been done—the Great Southern Railways Company of Ireland converted the 10 miles of the Clonmel and Waterford line—otherwise single throughout—that lay between Fiddown and Waterford. The work was completed on October 20th, 1929, and thereupon the Waterford Harbour Commission and the Waterford Corporation obtained judgment from the Irish Railway Tribunal that that should not have been done. The railway company appealed against this decision on the ground that there was no statutory obligation on the part of the railway company to maintain the whole or any portion of the railway as a double line or to maintain it at all. The Court of Appeal has referred the matter back to the Railway Tribunal to re-hear.

AS briefly related in our issue of June 5th, the railway accident returns for 1930 have been issued in the form of a preliminary statement. Having regard to the greatly reduced goods traffic of the last two or three years, one must be prepared for correspondingly lower figures. The 843 train accidents of every kind compare with an average of 1009 per annum for the five years 1920–1924, and the 7022 failures of equipment and track with an average of 11,153. There is the big drop from 235 derailments in 1929 to 174 in 1930, but the 242 collisions is about the average. Failures of couplings fell from 7760 in 1928 and 8327 in 1929 to 6676. We should be inclined to comment favourably on the fact that, in addition to only one passenger being killed in a train accident, only four servants lost their lives under similar circumstances, were it not that for the present year up to the end of May seven passengers and seven servants had been killed in five accidents to trains. Despite the considerably less goods traffic, the number of servants killed in "movement" accidents remains at just over 200 a year.

Notes and Memoranda.

AT the end of the last financial year—March 31st—the total number of telephones in Great Britain was 1,982,171, of which 712,493 were in London. The United States, with three times the population, has eleven times the number of telephones—22,000,000, and nine other countries, including Canada, Sweden and Germany, have a higher ratio of telephones to population than Great Britain.

IN future the power requirements of the Welland Ship Canal in Canada for operating the locks and such purposes are to be provided by its own hydro-electric plant. Three 5000 horse-power Francis turbines working under a head of 160ft. will generate 6600-volt three-phase current at 66⅔ cycles. The current will be stepped up to 22,000 volts for transmission along the canal. The plant is to start working this summer.

IT is claimed that the new ferry boat "Charlottetown," recently launched at Lauzon, is the largest vessel yet built in Canada. She is to ply across Northumberland Strait between the mainland and Prince Edward Island, and is of 4800 tons. She is 324ft. long by 50ft. beam, and has a speed of about 15 knots. There is accommodation on board for 16 railway cars, 50 motor cars and 750 passengers. The width of the crossing is 9 miles.

ACCORDING to W. Paul, of Düsseldorf, the resistance to the flow of steam through pipes bent with creases, or corrugations, round the insides of the bends, is not so great as might be anticipated. The loss of pressure is, he says, 60 per cent. higher than that of plain tube bent to the same radius, but if the flexibility of the bend is taken into consideration the drop is actually less on account of the greater length of pipe necessary if the creases are omitted.

ALUMINIUM paint as a primer under ordinary house paints constitutes a significant improvement over the standard painting practice by keeping the coating intact longer and by maintaining more adequately its protection against the weathering of the wood. The improvement is especially marked on woods containing much summerwood, and although in such cases it does not prevent the ultimate failure of the coating through flaking, yet it delays it considerably, and seems to be the nearest approach yet to a solution of the problem.

IN an address at the Royal Dublin Society, Mr. R. Borlase Matthews expressed the opinion that the river Shannon hydro-electric power scheme was one of the finest things that could have happened for the benefit of Irish agriculture. As the applications of electricity to agriculture in Ireland were only in their beginnings, the importance of starting by using the best and most suitable equipment was emphasised, and the hope expressed that full advantage would be taken of what had already been done in Europe. Emphasis was laid on the importance of electrifying a number of farms in each district to be used for demonstration, and also on the important part which educational campaigns must play in the development of rural electrification. The lecture was illustrated with kinematograph films showing electrically operated machinery in use on different farms.

THE Polish Statistical Department reports that the electrical manufacturing industry of Poland, working at about 60 per cent. of production capacity, produced equipment valued at £2,749,475 in 1930. The leading item of manufacture was electric wires and cables, which had a value of £936,745, thus accounting for about a third of the total. The lamp factories produced 5,544,065 lamps, valued at £285,525. Other leading items were: Accumulators and parts, £253,000; A.C. machines, £189,485; telephones and parts, £149,795, and telepohne batteries and other accessories, £122,290. In recent years the Polish electrical industry has only supplied 55 per cent. of the country's requirements, the remainder being met by imports. According to the return, there are 45 works in the country engaged in electrical manufacture, all of which, with one exception, were in operation last year. The number of employees fell from 6025 in 1929 to 4903 in 1930.

THE Secretary of State for the Home Department has made a general medical scheme which came into force on June 1st, 1931, for the purpose of co-ordinating the medical arrangements for the examination and certification of cases under the different workmen's compensation schemes for silicosis and asbestosis. Under this general medical scheme a medical board has been appointed which will act for the whole country and will be responsible for making the examinations and giving the certificates required for the purposes of any of the compensation schemes. Dr. C. L. Sutherland, 37, Exchange-street, Sheffield, has been appointed Chief Medical Officer of the Board, and panels of the Board have been set up at Bristol, Newcastle-on-Tyne, Sheffield, and Stoke-on-Trent. The remuneration and expenses of the Medical Board will be paid out of a Medical Expenses Fund, administered by trustees appointed by the Secretary of State, which will be maintained by fees payable by or on behalf of employers and workmen in respect of the examinations made and certificates given under the scheme, together with a contribution from the Treasury. The fees payable are those prescribed in the Silicosis and Asbestosis (Medical Fees) Regulations, 1931. The Secretary of State has also made a scheme of compensation for the asbestos industry, and has extended the various industries and metal grinding industries (Silicosis) schemes to include cases of workmen who, though not totally disabled, are certified to be suffering from silicosis to such a degree as to make it dangerous for them to continue in the processes included in the schemes. The new medical arrangements will apply to the refractories and sandstone industries, as well as to the industries covered by the various industries and metal grinding schemes, and the schemes for the refractories and sandstone industries have been revised accordingly. Copies of the schemes and of the regulations may be purchased directly from H.M. Stationery Office at the following addresses:—Adastral House, Kingsway, London, W.C. 2; 120, George-street, Edinburgh; York-street, Manchester; 1, St. Andrew's-crescent, Cardiff; or through any bookseller.

Miscellanea.

A FACTORY for the manufacture of radio apparatus is being put up in Montreal at a cost of 500,000 dollars.

IT has been announced by the Chinese Government that the new Business Tax will be applied to native and to foreign firms alike, regardless of any extra-territorial rights.

ARRANGEMENTS have been made for the driving of a tunnel between the 3600ft. levels of the Kirkland Lake Gold Mine and the Teck-Hughes Mine, in Ontario, with a midway refuge station, for improving the safety of the miners.

DURING 1930 over 103,000 photographs were taken from the air by the Royal Canadian Air Force in connection with Canadian surveys. These photographs are being added to the records maintained by the Topographical Survey, Department of the Interior.

THE erection of a 2,000,000-dollar terminal building in Montreal East is, says the *Canadian Engineer*, contemplated during the coming summer for the purpose of catering to the numerous British manufacturing concerns, which have announced their intention of opening branch plants in the city. A site, involving 500,000 square feet, has been chosen for the proposed six-storey structure.

PETROLEUM production in Alberta reached a total of 149,748 barrels during the month of March, 1931, according to figures compiled in the Department of the Interior, and based on the reports of operators. This was an increase of 40,000 barrels over the same period last year. The March, 1931, total was made up as follows:—Naphtha, 140,217 barrels; light crude, 8302 barrels; and heavy crude, 1229 barrels.

WHAT is believed to be the first considerable shipment of British steel plate to reach Central Canada for some years arrived at the Toronto Terminal Warehouse for delivery to the Toronto Ironworks, Ltd., on Monday, May 4th. This shipment of 1000 tons of steel plate is a direct result of the reduction in tariff made last year on British steel, and is the first that this firm has had from the Old Country, the previous source of supply being the United States.

WE are glad to note that among the names included in the Birthday Honours List are those of two soldiers whose work and training have been largely on the mechanical side. Colonel R. Oakes, C.B.E., who has been made a Companion of the Bath, is President of the Royal Engineer Board. Colonel W. A. Quennell, who has been appointed a Companion of the Order of the British Empire, is Assistant Director, Ordnance Services, War Office. Both these officers are members of the Institution of Mechanical Engineers.

THE Bolivian Government has agreed to the International Tin Committee's unanimous recommendation for a further cut in the tin quota, which will effect a total restriction of 33 per cent. on 1929 production. The revised quota was brought into operation in Bolivia on June 1st. The new quota, which, it is anticipated, will be enforced immediately by the other participating Governments, will reduce total world output to an annual amount of 125,000 tons, compared with world production of 145,000 tons under the previous quota figures, and 186,518 tons in 1929. World consumption for 1931 is estimated at approximately 140,000 tons.

A CABLE from Bangkok announces that the new Memorial Bridge, built by Dorman, Long and Co., Ltd., at a cost of nearly £300,000, was formally handed over on June 4th, after all tests had been satisfactorily carried out. H.R.H. Prince Purachatra, Minister of Communications, has also cabled his personal congratulations to the contractors on the successful completion of their work, four months in advance of the stipulated contract time. The bridge, which was built to commemorate the 150th anniversary of the foundation of the City of Bangkok, carries a roadway across the river Chow Pnya, in the centre of the city, and has a large central opening span of the bascule type to allow for shipping passing through Bangkok.

IT was reported at the recent meeting of the North Riding (No. 2) Executive of the National Farmers' Union that, after many months of negotiating, an agreement had been reached with the Central Electricity Board with regard to the wayleaves for overhead electric wires carried over agricultural land in the Executive's area. The agreement was fixed with regard to terms and annual sums, and there was now a sound and harmonious working with the Board. An important point was that any person in the area who had signed any form of consent in the past, many of which were unsatisfactory, could have the new agreement substituted for the old one without trouble or expense. The farmers had got what they had wanted for over twelve months—a common form of agreement for all electricity wayleaves. The position had been established without any friction with the landlords, who had, in every case, recognised that the only possible thing was for the tenants to have their own agreements with the electricity companies apart from the landlord's agreements.

ACCORDING to the latest official statistics the total number of telephones operating in Great Britain at the end of the last financial year—March 31st—was 1,982,171, a net increase for the year of 100,061, or 5·3 per cent. By that date one-fourth of the subscribers in Great Britain were served by the automatic system. Of these telephones, London had 712,493, an increase of 36,710, or 5·4 per cent., over the previous year's total. The smallest proportionate increase occurred in Scotland, whose system, embracing 173,416 telephone stations, was increased by only 7232, or 4·4 per cent. Northern Ireland, with an addition of 1638, or 7 per cent., claimed the largest percentage increase in the British Isles. The total number of call offices was 34,618, of which 6872 were in the London area and 27,746 in the provinces. The net addition during the year was 3527. This is an 11 per cent. increase over the total for the previous year. The number of effective calls originated during the year 1930–1931 is estimated by the Post Office at 1,371,000,000, or 49,000,000 more than the corresponding total for last year.

THE KILL VAN KULL BRIDGE, NEW YORK

(For description see page 647)

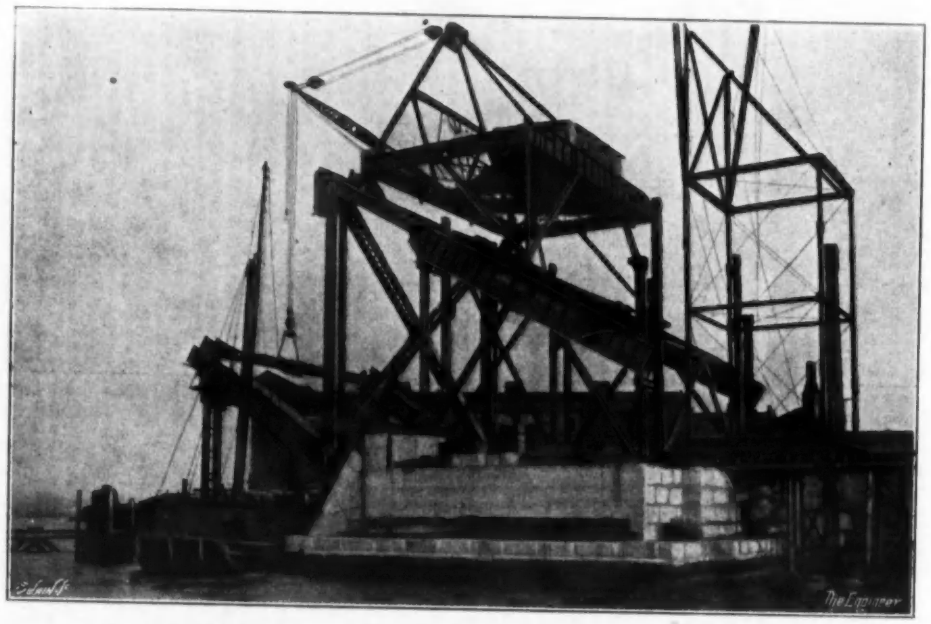


FIG. 10—ARCH ERECTION, PORT RICHMOND—NOVEMBER 20TH, 1929

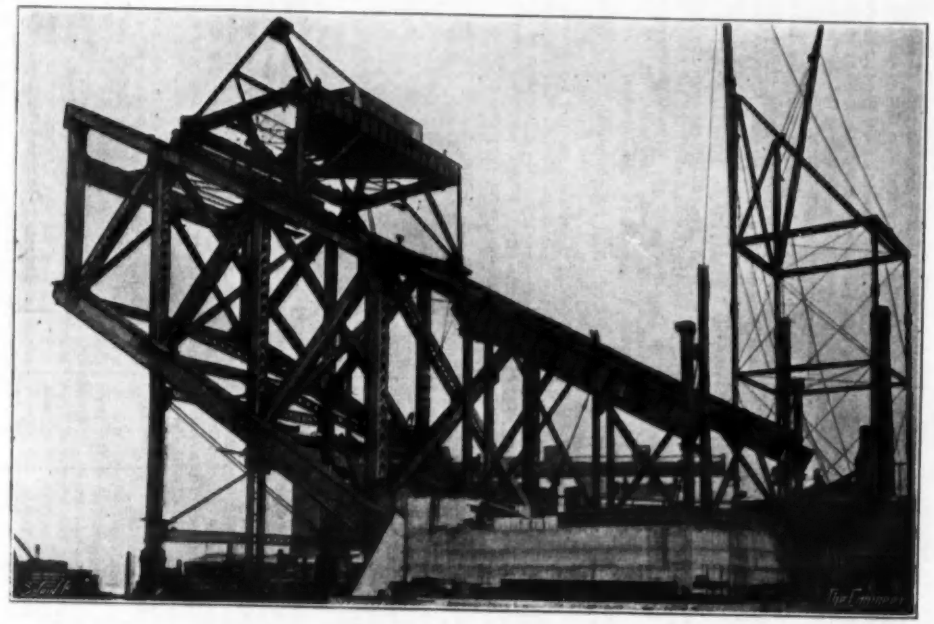


FIG. 11—ARCH ERECTION—DECEMBER 26TH, 1929

FIG. 12—ARCH ERECTION—JANUARY 29TH, 1930

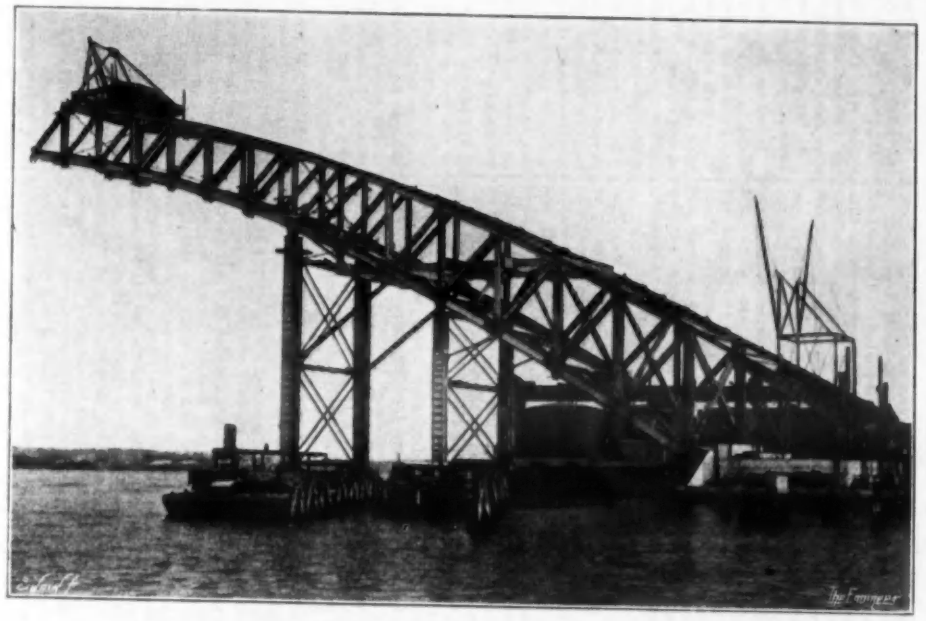


FIG. 13—ERECTION OF PORT RICHMOND ARM COMPLETED—APRIL 1ST, 1930

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THE ENGINEER.

VOL. CLI No. 3935

JUNE 12, 1931.

Noise Problems in Electrical Machinery.

FROM recent articles and papers published in this country and America, it is evident that electrical engineers are finding it essential to pay increased attention to the reduction of mechanical noise. Last year we referred to a paper bearing upon this subject, read by Messrs. Churcher and King before the Institution of Electrical Engineers, and to two other papers dealing with the matter from a rather different standpoint, read before the American Institute of Electrical Engineers. The authors of the paper presented in London confined themselves to the analysis and measurement of noise, whilst the American authors were rather more concerned with machine design. From the interpretation of the results of measurements made in accordance with Messrs. Churcher and King's methods on machines of various types, valuable knowledge relating to the cause of noise is said to have been acquired, and as a result more silent machines have been produced. In America similar work has been done. Several manufacturers have become greatly interested in methods of accurately and quickly measuring the noise of their products, such as ball and roller bearings, gears, and electric motors. During the past five years 250,000 dollars, or £50,000, are said to have been spent by the Michigan University alone on experimental work in this connection, whilst certain national societies, including the National Electrical Manufacturers' Association and the American Society of Mechanical Engineers, have appointed committees to consider the subject. In the May issue of *Electrical Engineering*—now the official journal of the American Institute of Electrical Engineers—fourteen pages are devoted to abstracts of papers presented at a special noise abatement meeting held at Rochester, N.Y. Earlier in the year a paper on "Reducing Noise from Power Transformers," also appeared in that journal. Taken as a whole, these papers form a useful addition to the published information on noise problems, particularly in connection with electrical machinery which frequently has to operate in residential areas where noise is liable to result in costly litigation. Even a transformer, although a static piece of apparatus, may prove objectionable on account of its hum. Electro-magnetic pulsations set up by the alternations of the current in the windings give rise to mechanical vibrations which usually originate in the core and coil structure, and are transmitted by the oil to the tank, and as the resulting continuous hum is of a comparatively definite pitch, it is liable to prove annoying. The noise produced by a transformer, however, is not so difficult to deal with as that of certain electrical machines. Briefly, transformer hum may be reduced by adopting a low flux density, by stiffening the bracing and supporting parts, and in some cases by adding damping devices to change the natural period of vibration. The practice of placing cork pads under transformers has often proved beneficial in the case of units erected in buildings, whilst hedges, shrubbery, and trees have proved useful for the prevention of nuisance in the case of outdoor transformers.

Like engineers in this country, those in America have found that in order to control noise a thorough understanding of its cause and mode of transmission is necessary. Accurate measurements have been found to be distinctly helpful in this connection, and with instruments now available information that serves as a basis for changes in machine design can be obtained. Two types of measuring devices are essential, one to give, as far as possible, an indication of the intensity of the sound to enable manufacturers to determine whether a machine comes within certain prescribed limits of quietness, whilst the other must be capable of analysing the sound into its components, so as to enable the designer to determine and eliminate the principal sources of noise. When attempts were made to devise an instrument to give an indication of the degree of noise, from a given source, serious difficulties were encountered, but a sound meter has, nevertheless, been devised which to some extent at any rate meets the requirements. One method employed for analysing the sound into its components and for determining the intensity of each component, is to use a microphone to pick up the sounds, which are then amplified and passed through a variable filter. As only one component goes through the filter at a time, it can be measured by an indicating device, such as a galvanometer, a method which, although slow, gives information which is of great value to designers. As we explained when discussing Messrs. Churcher and King's work in our issue of May 30th, 1930, by analysing the sound emitted by a motor or other machine, the source of each disturbance can usually be detected, and the design can be modified until an approach to inaudibility is obtained. In most cases each source of sound gives rise to a characteristic frequency. The blades of a fan, for instance, will set up pulsations in the air equal to the number of blades multiplied by the number of revolutions per second. A fan with ten blades, running at 1500 revolutions per minute, will give a frequency of 250 cycles per second. Conversely, if it is found that the frequency of the note, divided by the number of revolutions gives the number 10, and there are ten blades on the fan, it is reasonable to conclude that the note is caused by the fan. In a similar manner, the components of the total sound wave caused by the armature slots and by the commutator bars on a D.C. machine can be identified. Under certain conditions, the use of elastic supports has been found advantageous in the way of preventing the transmission of noise through the foundations of machines to the framework of buildings. Motor generators have, for example, ceased to give trouble when mounted on rubber pads, but such methods of dealing with noise troubles are, of course, distinct from those that aim at eliminating the cause. But until engineers succeed in making all machines operate more or less silently, schemes devised to confine the noise to a sub-station or other building cannot be ignored. The practice of enclosing converters in a casing has been adopted in at least one London sub-station, which previously gave rise to serious complaints. The same scheme has been adopted in various sub-stations in America and probably elsewhere, but blowers have had to be provided to keep the machines cool. In the case of an American sub-station recently built below a theatre, very elaborate precautions have had to be taken to prevent the transmission of noise. Besides totally enclosing the converters, it has been necessary to mount them and their associated transformers and blowers on cork foundations, to provide the air-blast ducts with canvas joints, and to insert flexible laminated

copper strips in some of the electrical conductors. As far as American converting machinery is concerned, the noise investigations that have been undertaken do not appear to have resulted in great improvements. For reducing the noise of some 750-volt series connected rotaries, which cannot be enclosed on account of possible "flash-overs," a new form of pole tip has been devised, but no authentic information is available concerning the results obtained.

In these days, however, there is very much less reason for engineers to bother about reducing the noise of converting plant than there was a few years ago. Since the introduction of the mercury vapour rectifier, troubles of this nature can be greatly diminished so far as sub-station plant is concerned. Apart from the hum of the transformers, which is governed largely by the flux density, and the small amount of sound emitted by the rotary vacuum pump, rectifiers are silent in operation, and can be installed in places where machines might give rise to complaints. But while rectifiers have to a large extent made it unnecessary for electrical manufacturers to produce quiet-running converters, there is still plenty of scope for the use of noise-analysing and testing apparatus, which, although designed by electrical engineers for use in electrical factories, should also be of value to mechanical engineers who are interested in the problem of reducing noise.

Fuel-Alcohol in France.

In the second series of conferences on motor fuels held at the International Colonial Exhibition in Paris, the conclusions arrived at were that technical difficulties in the way of providing substitutes for imported petrol have been overcome and that the only impediment lies in the prime cost of such fuels. Leaving out benzol, which is at present produced only in limited quantities for mixing with other fuels, alcohol is regarded as the hydro-carbon that must come into general use in the Colonies and as a complement to other fuels at home. Both benzol and alcohol possess the valuable property of being free from the phenomenon of engine knocking. On the Continent, the use of alcohol as a fuel is a national problem, and is bound up with the question of national defence. More than any other motor spirit it will continue to be developed until it can be employed economically for power purposes. Both in Germany and Poland the mixture of alcohol with imported fuels is compulsory, and now the Office National des Combustibles Liquides has reported to the French Government upon the necessity of enforcing the inclusion of at least 20 per cent. of alcohol, which the State will supply at the same price as petrol, in motor fuels. It does not necessarily follow that the compulsory employment of alcohol will make that spirit popular amongst French users. If the mixture is as good and as cheap as petrol, patriotism will do the rest, but the most energetic appeals of the Government to favour alcohol as a factor in national defence failed to induce motor car owners to accept the "national fuel" some years ago, when petrol importers were required to add 10 per cent. of alcohol to their spirit. Since then progress has been made in the way of obtaining a more homogeneous mixture which will possess stability at varying temperatures. The results communicated to the Conference appeared fairly convincing, and there appears to be no doubt that a mixture of at least 20 per cent. of alcohol with petrol can be used satisfactorily in petrol engines with a suitable carburetter adjustment, though with rather less power for the same volume.

The main incentive to the use of alcohol as a fuel is, of course, the importance of producing and stocking a sufficient quantity of the spirit for the manufacture of explosives in time of hostilities. It would be futile to ignore the fact that such a contingency exists, for it is constantly referred to in the discussions on national fuels. The French State monopolises the purchase of alcohol, which is paid for at varying rates, and prices have now been reduced to a level which beet growers affirm to be entirely unprofitable. The stocks of alcohol accumulated by the State are so unwieldy that it would be to the interest of the State to suspend the production of the spirit, but this step cannot be taken for fear of reducing the sources of supply. The supplies must be maintained at all costs. Therefore, it appears that the only alternative is to sell alcohol from stock at below cost price to be mixed with other fuels. The country will pay the difference in taxes, and users will pay a little more for their fuel, because they will get less power for a given volume, though the Office National des Combustibles Liquides is anxious to convince them that they will find compensations, such as an absence of engine knocking. With a compulsory mixture of alcohol with other fuels the consumption of the spirit will be sufficient to absorb all that is being produced by the beet growers. Another proposal is to supplant imported fuels progressively, so that engine builders may be induced to adapt their products to the use of variable mixtures, and, eventually, to evolve high compression engines for pure alcohol which are regarded as necessary for the African Colonies. The alcohol engine is of great value in tropical countries, where the waste of petrol as a result of evaporation raises the price to the consumer to an almost prohibitive level. At the same time tropical and sub-tropical countries possess inexhaustible quantities of material for the supply of alcohol, and by the use of vegetable refuse it is claimed that the cost of alcohol in the Colonies would not be more than 2f. per litre—about 1s. 6d. per gallon. On the other hand, the Bethune collieries are producing synthetic methyl alcohol which cannot compete with petrol on account of its much lower heat value—4200 heat units per kilogramme—but which, in view of the immense quantities that can be produced from coal will, it is claimed, make a useful mixture with benzol and petrol. At present, however, the selling cost is twice that of the estimated cost of colonial alcohol.

So much prominence would not be given to fuel-alcohol if it were not for the political importance of the product. The spirit of itself would need no such support if it could be manufactured at a competitive cost commensurate with its lower heat value. In the case of colonial alcohol, the spirit produced from vegetable refuse may be economical, but alcohol from wood would be a far more expensive fuel than torrefied wood used in gas generators. Alcohol is a particularly useful fuel for high compression engines in hot climates. Attempts to make the use of alcohol compulsory by motor car owners on the Continent will not tend to cheapen fuel supplies; but they may, to a certain extent, achieve the object of rendering European countries partially independent of foreign supplies of petrol and of helping agriculture.

The Institution of Civil Engineers' Conversazione.

THE Institution of Civil Engineers held its annual conversazione on Wednesday last, June 10th. The members and guests were received in the Great Hall, by the President, Sir George Humphreys, and Lady Humphreys. As usual, the Institution buildings were tastefully decorated with flowers, and the band of the Royal Regiment of Artillery gave selections throughout the evening. In the theatre on the first floor concerts were given by Moiseiwitsch and Melsa between 9 p.m. and 9.45 p.m., and from 10.15 p.m. until 11 p.m., whilst in the north reading room on the ground floor three lectures were given. Professor S. M. Dickson spoke on "Safety in Mines"; Mr. H. E. Stilgoe discussed "The Rivers and Streams of Old London," whilst Mr. D. Alan Stevenson dealt with the subject of "The Development of Lighthouses from Fire Tower to Talking Beacon."

The exhibition of engineering models, scientific apparatus, &c., arranged for the inspection of visitors contained many interesting items, including a very fine model of Mr. Gresley's high-pressure locomotive. Some of the exhibits related to civil engineering, others to mechanical engineering, and a few to the lighter branches of electrical engineering. The Department of Scientific and Industrial Research, the Radio Section of the Engineer-in-Chief's Department of the General Post Office, the Research Section of that Department, the National Physical Laboratory, and the Directorate of Scientific Research of the Air Ministry were represented. Mr. H. E. Stilgoe, chief engineer to the Metropolitan Water Board, exhibited several interesting relics, including a small gun-metal force pump belonging to the London Bridge waterworks, and a manuscript book entitled "The State of the London Bridge Waterworks, Anno 1745, by Samuel Hearne, Secretary and Surveyor of the Said Works." A section of an old London water main was shown by Mr. W. H. Patchell, whilst Mr. C. G. Hawes showed a model of a group of regulators on the Rohri Canal of the Lloyd barrage scheme in Sind, India.

Professor E. H. Lamb, of the East London College, E. 1, exhibited a static balancing machine, designed as a workshop appliance for the accurate balancing of steam turbine discs, pump impellers, pulleys, &c., the model being suitable for such articles weighing up to 4 cwt. and having a maximum diameter of 36in. A special feature of the machine is that the body to be balanced requires no mandrel or axle to be fitted to it for the operation, and it is possible accurately to determine a mass-moment of about 0·005 foot-pounds in the case of a turbine disc weighing 2 cwt. in the short space of 5 to 10 minutes.

The "Carrier-Owen" air preheater was exhibited by Mr. W. H. Owen, of the Carrier Engineering Company. By the use of this apparatus, the fundamental process of combustion is claimed to be greatly improved. The flame is shortened and the volatiles and combustible gases are quickly and completely ignited before coming into contact with the cold heating surface. Formation of soot is thus prevented and the heating surfaces can be maintained in a clean condition for extended periods. Less excess air may be used and a higher CO_2 content carried without the production of smoke. This, Mr. Owen explains, increases the furnace temperature and, consequently, more of the heat of combustion is absorbed by radiation in the furnace itself, and the gases leave the boiler at a lower temperature. Thus, the reduction in the weight of gases made possible by heating the air acts in a two-fold way to reduce chimney losses, quite apart from heat recovery in the preheater. Another advantage claimed is that cheap, low-grade fuels which could not otherwise be economically burnt, may be used. The heating surface is made up of steel plate cells closed by welding along the edges, except where openings are left for the entry and exit of the air. The cells are arranged side by side so that the air flows through the cells and the waste gases through the spaces left between them. In order to facilitate handling, transport and erection, the cells are assembled in elements, each element being enclosed in a rigid angle iron frame into which the cells are permanently welded. Bolts, provided with distance pieces, pass through the elements to ensure accurate spacing. The edges of the openings in the cells are also welded together, so that air cannot pass into the gas spaces, the whole forming a perfectly air-tight and rigid structure. At each end of the elements, definite faces are formed surrounding the openings for the entry and exit of the air to and from the cells, these faces being provided with gaskets for making air-tight connections to the air ducts. The elements are assembled in a substantial mild steel casing, which forms a portion of the flue and is a permanent structure. Air ports are formed in the side of the casing having flat joint faces corresponding to the faces on the heater elements. The elements are drawn up to the ports by means of clamp bars and hook bolts, the whole forming a sound and mechanical joints. The air inlet and outlet ducts are fixed to the outside of the casing. Above each row of elements a runway track is provided which can be extended externally by means of removable brackets when the access doors have been removed. On this track there is a trolley, which is provided with lifting gear for running the elements in and out of the casing. The "Carrier-Owen" system of double heating with divided air supply comprises two air preheaters, namely, a secondary and a primary heater. The flue gases leaving the boiler enter the primary heater and then pass through the secondary heater. When an economiser is employed, it may be placed between the two air heaters, or when the temperature of the gases from the economiser is high, the two air heaters may be arranged in series after the economiser.

In the primary heater the whole of the air for combustion is raised in temperature to about 260 deg. Fah. The air is then divided into two portions. The larger portion—usually about 75 per cent.—forms the primary air supply and is admitted underneath the grate in the usual manner, the comparatively low temperature of this air having no harmful effect on a modern grate. The remainder of the air is passed through the secondary heater where it is raised to a very high temperatue and is then admitted over the fuel bed.

Among other things Mr. J. L. Hodgson, of George Kent, Ltd., exhibited a portable sensitive manometer and pitot tube, as used on the Mersey Tunnel ventilation scheme. The apparatus consists of a curbed tube manometer, which has an equally spaced flow scale down to one-fifteenth of the maximum flow, and a spherically ended pitot tube, which is claimed to be less sensitive to the effect of "yaw" than the standard N.P.L. type of tube. Limitations of space will not allow us to refer to all Mr. Hodgson's exhibits, but brief reference may be made to an automatic temperature control apparatus of the electrically operated thermo-couple potentiometer type, capable of measuring, recording and maintaining industrial temperatures, such as the cracking temperature of petroleum oil, with great accuracy. The chart, which is 10in. wide, covers a range of 200 deg. Fah., and the instrument is so constructed and calibrated that accurate control may be obtained to within plus or minus 1 deg. Fah. at 1000 deg. Fah. The galvanometer and the operating mechanism are enclosed in a gas-tight case, which entirely protects them from dust and corrosive fumes, and for oil refinery work all parts carrying high-voltage currents are suitably protected or fitted with flameproof casings. The temperatures at which the apparatus operates can be adjusted from outside without opening the case. The automatic controller is designed to take into account both the actual plus or minus deviation from the

standard temperature, and also the plus or minus rate of deviation. It is arranged so that it makes a relatively large adjustment when the rate and the deviation are of the same sign, but a very much reduced adjustment, or no adjustment at all or even an adjustment in the opposite sense, when the rate of the deviations and the deviations are of opposite signs. This method of operation is claimed to give the quickest possible response under any given set of conditions, and at the same time eliminates hunting. To enable this type of control to be effected it has been necessary to develop a new form of instantaneously acting mechanical clutch, which has been found to work continuously without noise or wear, and permits of a precision of operation that is said to be unapproached by any previously existing device.

Professor E. G. Coker exhibited some coloured photographs of railway wheels during construction and under load. The stresses produced in the construction of built-up wheels, and the additional stresses caused by use, are of considerable importance in practice, and Professor Coker's photo-elastic experiments are useful in elucidating their distribution. Very complicated stress distributions are found in the spoked wheels used on railways. When an axle is forced into a wheel centre great stress is naturally experienced in the hub, but relatively small stress is found in the spokes and rim. In the hub the radial pressure mounts up until it attains a maximum value at the axle, and the much greater circumferential stress does the same. At the axle an interesting feature is also observed. The radial pressure between the axle and the hub mounts up at points directly opposite to a spoke, so that this radial pressure waxes and wanes around the circumference of the axle. The circumferential stress does the same, but with the important difference that the maximum values of the stress distribution alternate with those of the radial stresses. Shrinking a tire on to a wheel centre, whether provided with an axle or not, causes considerable stress in the spokes, but the feature of importance is in the tire itself, for it is found that the circumferential stresses have a maximum value at the outer edge of the tire opposite the spokes, but midway between them the greatest intensity is at the inner edge of the tire.

Alloys of steel with special properties were shown by Sir Robert Hadfield. There was a deep-pressed vessel made from "Era C.R. 1" non-corrodible steel, the vessel having been cold pressed from a flat sheet 0·024in. in thickness. Specimens illustrating the difference in temper coloration of ordinary carbon steel and special alloy steels of the heat-resisting and non-corrodible type were also shown, together with steam pipe flange bolts of Heela 134 steel, and an improved steel of the nickel-chromium-molybdenum type, possessing excellent mechanical properties at elevated steam temperatures. There were also electrically butt-welded bars of "Era 131" steel, demonstrating that this material can be successfully welded to itself or to ordinary steel without difficulty. On account of its workability and high resistance to creep at advanced steam temperatures, it is particularly suitable for tubes and other parts of superheaters. Rolled rails of "Era" manganese steel produced in the electrically driven 28in. rolling mill at Hadfield's works were shown, as well as various other Hadfield products.

On behalf of Reavell and Co., Ltd., of Ipswich, Mr. R. L. Quertier exhibited three types of Askania regulating apparatus—a low-pressure regulator suitable for regulating pressures up to 30in. water gauge; a high-pressure regulator, for pressures up to 3000 lb. per square inch; and a ratio regulator, for controlling air and gas, which will maintain the mixture constant irrespective of the fluctuations in the pressure of either of the gases. All three regulators are arranged so that the interior mechanism can be seen, and they are electrically illuminated. The first two regulators mentioned are arranged to regulate irrespective of the volume, and to maintain the pressure constant to one-half of 1 per cent.

A model of a screw or axial flow pump was exhibited by Mr. J. H. W. Gill. This is a high-speed machine, running at from 1½ times to nearly twice the speed of a centrifugal pump designed for the same duty, and its action depends upon the difference of pressure generated by the combined wedging and whirling effects imposed upon the blades of the rotor. The pump that was exhibited was a scale model of certain marine circulating pumps recently constructed, but pumps of this design have been supplied for use where the requirements call for the raising of volumes of fluid or semi-fluid matter which are relatively large, and the heads pumped against are relatively low. It is for such duties, and especially in cases where considerable percentage variations in the head are likely to occur, that pumps of this design show to the best advantage, apart from the advantages which are conferred by their high speed, *i.e.*, small bulk and low weight.

Among other models shown was one of a bridge circus designed by Mr. H. W. S. Husbands to eliminate cross road traffic on the level, and a model of the proposed air port for central London, shown by Mr. C. W. Glover. Methods of measuring noise were demonstrated by Dr. A. H. Davis and Mr. R. S. Dadson, of the National Physical Laboratory; whilst Mr. H. O. Townend, who is also connected with that establishment, demonstrated a method of rendering air flow visible by means of hot wires. The National Physical Laboratory had a very fine display of apparatus of various kinds, including a standard resistance for the measurement of direct currents up to 25,000 ampères.

Literature.

A Laboratory Manual of Electrochemistry. By Dr. ERICH MÜLLER, Professor and Director of the Laboratories of Electrochemistry and Physical Chemistry, Technische Hochschule, Dresden. Translated from the Fourth Edition by H. J. T. ELLINGHAM, Ph.D., A.R.C.S., A.M.I. Chem. E., Lecturer in Physical Chemistry, Imperial College of Science and Technology, London. London: Routledge. 1931. Price 15s. net.

A GREAT many books on electrochemistry have appeared of late years in the English book market, but almost without exception they have soared in the realms of theory by preference, and treated the practical side of a highly practical subject as a necessary evil. Dr. Müller, in the book under review, has descended to earth and reversed the procedure, allowing the theory to emerge from the experiments described in a fairly successful way. The translator, Dr. Ellingham, evidently considered this a fault and tries to remedy it by frequent references to the book recently written by Dr. Allmand and himself. This the reviewer considers a perfectly unnecessary amplification, as the attempt to introduce the electron conception in electrochemical reasoning made by these authors is very much like using modern theories of light for calculating a microscope. This by the way. Dr. Müller's book is quite useful as it is, although some of his "practical" arrangements are too academic to be practical, and he, unfortunately, starts with the worst example. As early as page 5 he gives a scheme of coupling accumulators, which certainly is convenient for distributing varying voltages, but warranted to ruin the best accumulators in a short time, if used to any great extent. It is a multiple arc arrangement of four series groups of cells, two and two of the same voltage, discharging in parallel, all the groups being charged in series. To keep all the groups in step for charging in this way is, of course, an utter impossibility with the naturally varying loads on the different groups without seriously overcharging one or the other. With the trifling amount of work done in an educational laboratory this may not mean very much, but it impresses the student's mind with the idea that this is the right way of doing things, and leaves something to be unlearned. The best way, when using a main supply as a source of current, is to have separate motor generators for the different voltages, with accumulators, when this is necessary, and without whenever permissible.

The following chapter on necessary apparatus and accessories gives a new lease of life to forms of binding screws, terminals, clamps, electrode holders, &c. &c., which were used fifty or sixty years ago, and still survive, although they are unreliable and in some cases objectionable to work with, like an arm carrying both electrodes on one insulating bar—page 21. That the German fetish, the gas voltameter, is described in detail with a new form of gas burette, is only natural, but that it should be "extensively employed" astonishes the reviewer, who has made thousands of electrolytic experiments, including practically all given in this book, and never seen the necessity for using this highly inconvenient apparatus. As an offset the well-known "Reason" mercury ampère-hour counter is described. Several forms of the capillary electrometer are mentioned, and illustrated, but not a single form of electro-magnetic instrument is included. In connection with the instruments, it is rather amusing to note the piety with which famous names are tacked on to quite ordinary pieces of apparatus, like the "Ostwald decade bridge," in double-fat type on page 47, &c. &c. As it is not a decade bridge as ordinarily understood, but two rows of 10 and 100 ohms each respectively, and fairly clumsily contrived, it is somewhat difficult to understand why it should be given more than a page, and the recommendation of a great name. On the whole, this chapter contains only one novel apparatus of a striking nature, viz., the Mylius-Fromm stirrer actuated by a filter pump—pages 53–55. It is no better and no worse than what one finds in most text-books on the subject. The reviewer thinks that a chapter on *how to make and arrange* electrochemical apparatus ought to have found a place in conjunction with these descriptions. A modicum of workshop practice is very essential to a future research worker in electrochemistry, and the earlier it is acquired by the student the better. To give an example, we are often met with the problem of making a good contact between a carbon anode and the positive lead for electrolysis of, say, brine. One of the best ways is to cast a lead lug round the end of the carbon with the aid of a two-part mould. Now, there is a critical temperature at which the mould and carbon should be kept to make a sound job. Another temperature is suitable for aluminium, &c. &c. Hence, a chapter on artifices like these would not disgrace any book on electrochemistry; in fact, it is highly essential.

So far the book shows little merit out of the ordinary, but the following section on fundamental laws is of its kind a masterpiece. The experiments start at the beginning and proceed in a pedagogically correct sequence to include quite a respectable part of all that is actually needed by the practical electrochemist for understanding the theoretical basis of his science. The diagram references are admirably arranged and complete, and very little is left to the student's imagination—a very wise precaution—and the experiments are well chosen. Amongst other noticeable things one observes the astonishing ease with which the author leads up to the Nernst-Planck theory of potentials with simple experiments, and the set purpose of the sequence of everything, viz., to arrive at the practical application of it all. It is to be hoped that the book will obtain the reception it deserves from teachers as well as students by reason of the merits of this part, which should become a classic, like "Leitfaden der praktischen Physik," by Friederich Kohlrausch, of which it strongly reminds the reader.

In this section the author frequently employs the above-mentioned Ostwald bridge for potentiometric measurements, and it appears that the crude readings possible—down to 1 per cent. accuracy—are rendered more accurate by interpolation from the readings of a capillary electrometer. This principle has been applied in a number of instruments of greater refinement made in this country for use in conjunction with the reflecting galvanometer, but the reviewer thinks that for teaching purposes a true zero method should be employed, as the proportionality of the readings of a capillary electrometer or of a galvanometer is anything but an axiom. Such a zero method can easily be devised by coupling an ordinary resistance box in series with a bridge wire of known resistance, and using a plug provided with a terminal. It is also pedagogically wrong to simplify calculations by choosing an even decimal number for the total resistance of the potentiometer circuit.

There follows a section on electro-deposition of metals and electro-analysis. Starting with a theoretical survey of the feasibility of complete deposition of a metal, the section proceeds with separate cases as numbered experiments as in the rest of the book. No attempt is made to expand the method into a more or less universal system of chemical analysis as Classen tried to do, but the few examples cover almost all cases in which the method can be used with advantage. With regard to copper, it may be said that the preliminary conversion of the nitrates to sulphates is unnecessary, as the nitrates give good complete deposits of copper and allow determination of nickel and zinc just as well. The fairly complicated reactions through the reduction of the nitric acid by excessive cathode area do not interfere with the progress of the analysis after oxidation with bromine.

The sections on important inorganic and organic preparations, giving actual manufacturing processes in miniature, are delightful reading, and should form a valuable introduction to practical work, although they cannot be said to give any idea of the difficulties experienced when working on a large scale. This objection is perhaps more telling in the case of working with fused electrolytes discussed in the following section, as apart from the aluminium process as described, the others are of doubtful practical value, though they have been worked in practice. The reason is mainly that both fused chlorides and hot chlorine attack most ordinary materials, besides which the efficiency is impaired by re-combination in the case of magnesium to an enormous extent.

A chapter on electrothermal processes concludes this interesting book.

The translation has been carefully done, as might be expected, and no doubt a certain amount of editing has been attempted. As it stands, the book is a new departure, basing the reasoning on the experiment, and not *vice versâ*. Furthermore, the systematic introduction of miniature manufacturing experiments is novel, and the absence of irritating bibliographical references should be a relief to the user. One can only wish the author and his able translator good luck with this venture, which should be welcome to students and teachers alike.

BOOKS RECEIVED.

Applied Mechanics. By J. Boothroyd, B.Sc. London: Edward Arnold and Co., 41, Maddox-street, W. 1. Price 6s. net.

Oil and Petroleum Year Book, 1931. By W. E. Skinner. London: W. E. Skinner, 15, Dowgate-hill, E.C. 4. Price 7s. 6d. net.

A Text-book of Thermo-dynamics. By F. E. Hoare, M.Sc., &c. London: Edward Arnold and Co., 41, Maddox-street, W. 1. Price 15s. net.

Merseyside Employments for Boys and Girls: The Engineering Trades. Liverpool: The Liverpool Education Committee. Price 6d. net.

Power and the Internal Combustion Engine. By W. E. Dalby, F.R.S., &c. London: Edward Arnold and Co., 41, Maddox-street, W. 1. Price 18s. net.

Sags and Tensions in Overhead Lines. By C. G. Watson, M.I.E.E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 12s. 6d. net.

Cement Chemistry in Theory and Practice. By Professor Dr. Hans Kühl. Translated by J. W. Christelow, B.Sc. London: Concrete Publications, Ltd., 20, Dartmouth-street, S.W. 1. Price 7s. 6d. net.

THE MANUFACTURE OF PORCELAIN INSULATORS

FIG. 1—METAL SCREWING SHOP, TIPTON WORKS

FIG 2—METAL DRESSING SHOP, TIPTON WORKS

FIG. 3—FILTER PRESSES FOR PORCELAIN "SLIP," MILTON WORKS

FIG. 4—CLAY TURNING SHOP, MILTON WORKS

The Manufacture of Porcelain Insulators.

WHEN it is remembered that the ceramic industry is very much older than the electrical industry, it is not surprising that the manufacture of porcelain insulators was begun in this country by a firm previously engaged in the production of other porcelain goods. In December, 1840, a brother of Redvers Buller, who subsequently became General Sir Redvers Buller, founded a pottery business in Bovey Tracey, where operations were carried on for a period of 25 years, but, owing to the growing fame of the Staffordshire Pot Banks and the Staffordshire potters and the proximity of the coalfields, in 1865 the business was transferred to Hanley, in Staffordshire. Three years later the firm began to make telegraph insulators, complete with ironwork, for elsewhere in England a telegraph firm had come into prominence, and as a result of the work done for that firm, the porcelain insulators made by Bullers came to the notice of the Government. A year later the pottery firm co-operated with Mr. J. H. Cordeaux, the G.P.O. engineer, in the development of the "Cordeaux screw," for attaching the insulator to its metal spindle, and to this day this standard type of insulator is used throughout the British Empire.

Vital problems had to be solved in connection with the establishment of the first telegraph and telephone lines, whilst, in later years, similar problems had to be grappled with in connection with power lines. As the business developed, it became apparent that an engineering department, devoted to the production of the metal components for insulators, was essential. Hence, in 1883, a partnership was entered into and an agreement drawn up which set down that Ernest Wentworth Buller and John Thomas Harris should be engaged in carrying on a business as potters, metal workers and contractors, at Hanley, Birmingham and London. Two years later, the partners arranged with Mr. Howard Cochrane Jobson, who carried on a business known as Jobson Bros., to form a new company which was to purchase the Jobson Bros. telegraph, engineering ironfounding and contracting business, and that of Buller and Co. On June 8th, 1885, the newly formed business of Buller, Jobson and Co., Ltd., was duly incorporated, and the combined engineering and pottery plants proved highly advantageous in coping with the steadily increasing demand. On October 6th, 1890, the firm was incorporated as Bullers, Ltd., whilst nine years later, the concern, which had hitherto been carried on as a private company, was converted into the present public company.

When electric power began to show signs of coming into use, the firm kept well abreast of the times. In 1901, the London County Council Tramways Department was one of the company's important customers; in the following year the Crown Agents for the Colonies placed large contracts for high-tension shackle insulators, whilst in 1903 third rail insulators were supplied to the Metropolitan Railway. Each successive year provided equally important contracts. The long operating record of the insulators on the Victoria Falls power lines provides a typical example of the continuity and reliability of the firm's insulators on high-tension overhead lines. During the war the firm was "controlled," and in that capacity it worked day and night on the production of many specially designed articles for the military and naval authorities, as well as for civilian purposes. Since the war the company has carried out important extra high-tension overhead transmission line contracts in the British Empire, on the Continent of Europe, in America and elsewhere. When the National Electricity Scheme was introduced and 132 kV insulators and other overhead line equipment were called for, the long experience of the firm in meeting similar requirements in other parts of the world enabled it to cope with the work.

Even before the days of the war it was realised that the old works at Hanley would have to be augmented in order to meet the expansion of business, and it was decided to erect a new factory at Milton, some few miles from Hanley. Owing to the outbreak of the war, however, it was not until 1920 that production at Milton was begun. The Milton works provide an outstanding example of modern equipment, the layout having been designed with a view to ensuring direct sequence of each stage of production. But before considering the technical side of the pottery business, it should be mentioned that, in addition to the ceramic works at Hanley and Milton, the company has a third factory at Tipton, midway between Wolverhampton and Birmingham, which is mainly devoted to the production of metal fittings for use with the porcelain insulators produced at the Milton and Hanley factories, although it also produces castings and forgings for other purposes. These Tipton works—see Figs. 1 and 2—consist of machine shops, malleable and cast iron foundries, galvanising shops, test houses, warehouses, offices, and a private canal wharf. From small beginnings, the engineering section has developed until, nowadays, it turns out very large quantities of castings and forgings for telegraph, telephone and transmission lines, together with all classes of similar castings and forgings. Although there are other firms producing similar articles, the Tipton factory, it is claimed, gives Bullers, Ltd., the distinction of being the sole company in Great Britain producing both the porcelain and metal parts for insulator work. Many castings and forgings produced at Tipton are supplied to the railway companies for signal and track work, whilst others go to the motor car industry. The cotton industry at home and abroad provides good markets for fittings used in weaving machinery, whilst the rayon trade has created the "side line" of porcelain spools at Hanley and Milton. All things made at Tipton for use in overhead line work are tested to ensure that they will stand their full guaranteed load. The close liaison which exists between the engineering and ceramic branches as regards research work and production is of great value to the firm, for it facilitates design and standardisation. In view of the fact that the company's products have to withstand climatic conditions, exceptional importance is attached to galvanising, and the galvanising plant is operated so that every article is capable of undergoing the "Preece test," which is claimed to be the most severe test to which any galvanised article can be submitted.

Let us now turn to the technical side of the insulator business. In the manufacture of electrical porcelain, the weathering of the clays and the analysis and the grading of the raw materials are of the utmost importance, and to obtain the best results the company holds large stocks in various parts of the country. From these stocks samples are drawn from time to time, in order to ensure that the ingredients are of the necessary quality and uniformity for the production of high-grade porcelain. As required, supplies of the raw material are delivered to the company's private sidings and wharves and the materials are circulated to the various departments, where they receive the particular treatment which each has to undergo before being drawn into the central department, in which the manufacture of the mixture technically known as the "body," and which is ultimately to become porcelain, begins. The materials, such as felspar and quartz have to be crushed in special machines to the desired degree of fineness, whilst the clays have to be mixed with water into a uniform consistency, and after all the materials have been carefully tested, they are mixed together in predetermined quantities to a creamy consistency to form what is known as "body slip." The mixing of the materials is an extremely important operation, and much time has been devoted to the development of the best methods of maintaining a correct and uniform mixture. To remove any magnetic material which may be present in

the slip, it is passed over powerful electro-magnets and through fine sieves having as many as 20,000 to 30,000 holes to the square inch in order to ensure uniformity of the particles in the mixture.

The next step in the process is the conversion of the slip into clay by means of the special filter presses shown in Fig. 3, which consist of a series of canvas cloths held in trays and fed from a common connection under pressure. The slip is pumped into these trays and the water drains away and leaves the clay behind in the press. After the pumping process has continued for some hours, the press is opened and the clay is removed in flat rectangular slabs. The first stage in clay production has now been passed, but the material is not yet ready to be formed into

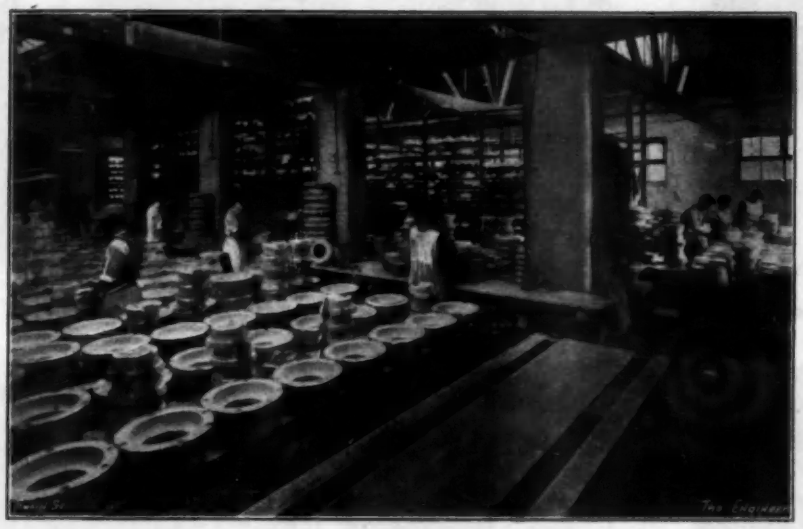


FIG. 5—CLAY CASTING SHOP, MILTON WORKS

insulators, for during the mixing and pressing processes the ingredients have been mixed with water in the presence of air, with the result that at this stage the clay has a certain amount of occluded air and moisture uniformly distributed throughout the mass, and as this would be detrimental to the production of a good insulator, the clay must undergo special treatment in order to make it suitable for use. The result of the foregoing processes is to produce what may be termed raw material for the potter, and the next step is to pass this material to the various making departments which may be classified under the headings of (1) throwing and turning, (2) jollying, (3) casting, and (4) die pressing, the method employed in the manufacture of any particular object being determined by its shape, size, and weight; also by the purpose for which it is required. The firm's experience in the manufacture of all kinds of insulators is of great assistance in determining the method of manufacture to be employed.

While the origin of the potter's wheel is lost in antiquity, and although it has undergone considerable changes in the details of construction, the principle of its operation remains the same. For many years it was the only machine used for producing the "forms" required for high-grade porcelain insulators, and it is still the best contrivance for the production of certain types of insulators. With its aid, the clay is formed into a definite shape, so that after it has been dried in a drying stove, it can be dealt with in a lathe. The throwing operation calls for a high degree of skill on the part of the throwers, who are men of long experience. The lathes in the turning shop—see Fig. 4—are similar to power-driven wood turning lathes, and the outside and inside shapes on the "forms" produced in the throwing department are made by means of profile cutting tools. Standard insulators, as used on the telegraph and telephone lines in this country, are produced in accordance with this method, and the threads made on them for attaching the insulators to the pins have to be correct in respect of diameter, form of thread, and depth to no fewer than four gauges, calling for an accuracy within a few hundredths of an inch.

This method of manufacture is also applicable to lighting distribution insulators, and small high-tension switchgear insulators. For the production of cap and pin insulator discs, pin insulators, and leading-in bushings, &c., for extra-high voltage transmission and for third-rail insulators for electric railways, use is made of the jollying process, which consists of working the clay by means of a cast iron tool and a revolving plaster of Paris mould. Broadly speaking, the mould forms the outside profile, and the tool the inside profile, and here again craftsmanship is of great importance. For the production of parts of more irregular shape a casting process is used which consists of pouring prepared slip into plaster moulds—see Fig. 5—which absorb the water from the slip. To this process the company has devoted a considerable amount of research. All the intricately shaped parts for switch bases, ceiling roses, cut-out boxes, &c., are made by die pressing, the material used being a finely ground dust produced by drying prepared clay until it has given up its combined water, and after this has taken place the material is passed through disintegrators and mixers which produce the finely and evenly divided dust. The steel dies used in connection with this process are made in the company's tool-making shops.

After production by one of the several methods described, the insulators are passed forward for preliminary drying and inspection. The preliminary drying process is necessary to remove some of the combined water, and to reduce the stresses during the firing process and also to render the clay dry enough to enable the liquid glaze to adhere to the surface preparatory to firing. The period of drying varies for different articles, according to their size, shape, and method of manufacture. After the insulators have been dried in the drying stove, they are dipped in liquid glaze, the composition preparation and application of which are matters of great importance, to which the company has devoted considerable research.

Of all the processes associated with insulator production, that of the conversion of the material from the clay state to the finished product, technically known as "firing," has probably undergone the most revolutionary changes, and here, again, the company has undertaken a great deal of research work. Exhaustive experiments covering the whole field of modern firing practice have been made, with the result that the company now adopts the best and most scientific methods. The old-fashioned bottle-shaped coal oven has been replaced by the modern type of gas-fired oven, and, as in the production of electrical porcelain, the control of temperature and atmosphere conditions is of vital importance, the firm has developed operating and control systems, which ensure accurate regulation and recording of the treatment given to the material through every stage of firing, with the result that during the firing process the body is vitrified and coated with a uniform layer of glaze of smooth and uniform texture.

After they have been drawn from the ovens all insulators are passed through a sorting and inspection department, where they are submitted to strict inspection. At this stage the treatment of the insulators depends on the purpose for which they are required and the test specified. Insulators, such as switch bases, &c., which do

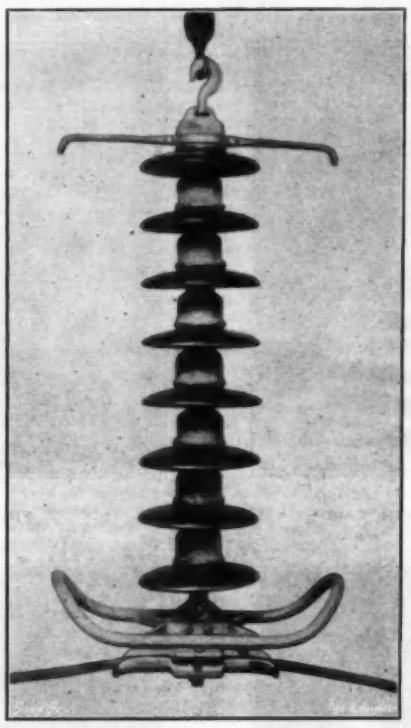


FIG. 6—STRING INSULATOR

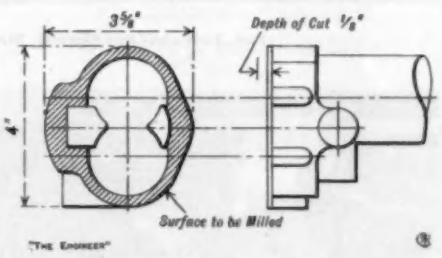
not require fittings can be forwarded to the packing department for dispatch. Others, however, call for further treatment, such as that of attaching fittings, cementing, testing, &c. Insulators for high voltage are taken from the preliminary sorting department to the high-voltage testing room, where they are subjected to a routine test and afterwards pass to the cementing or assembly rooms. Cemented insulators of the cap and pin type are subjected to a steam curing process, for the maturing of the cement, and are then ready for a routine mechanical test, which is followed by a routine electrical test. Every component of a high-tension insulator, as well as every complete insulator, has to pass a routine electrical test, and in some cases a mechanical test, before being dispatched for service. The treatment naturally varies according to the type or pattern of insulator, but the tests may be roughly divided into routine and type tests. Very special attention is paid to the testing of the units which go to make up a complete insulator string or pin insulator, for upon these tests the maintenance of a uniform standard of quality and performance largely depends. The electrical and mechanical testing departments in the insulator factories are departments of great importance, and are fully equipped with high-voltage, and low and high-frequency testing transformers and electro-mechanical testing apparatus for all types of insulators. At Milton a new testing laboratory has recently been built and is now in course of being equipped.

The research work carried out by the company may be broadly divided into two branches, ceramic and electro-technical, and great care has been taken to ensure the co-operation of these two branches, as it is only by the closest possible relationship between them that the requirements of the electrical industry can be met. The equipment of the two departments is naturally of a widely different character. Special apparatus is used for the checking and grading of raw materials, and electric ovens for the rapid firing of samples. While it is a fairly common idea that the performance of insulator units is mainly dependent on the shape and quality of the material used, a few elementary tests will readily show that in practice the fittings constitute equally important components of a complete insulator string. The performance of an insulator is controlled by design, material, and workmanship, and as this applies to the metal components as well as to the porcelain parts, the company claims that, as it is the only firm in Great Britain which has factories devoted to the production of both ceramic and metal components, it is in the best position to provide for the centralisation of research and design. Every type of insulator used in the electrical industry for telegraph and telephone work and for power work is made in the company's factories, including the cap and pin type insulator strings—see Fig. 6—as used for the 132-kV grid lines in this country.

Milling with Tungsten Carbide Tools.

IN order to encourage the use of tungsten carbide tools the Kearney and Trecker Corporation, of Milwaukee, issues periodically to its representatives brief descriptions of typical or remarkable machining operations. We receive copies of these descriptions through the courtesy of Burton, Griffiths and Co., Ltd., of Birmingham. The last one to hand deals with an interesting case of milling with an inserted tooth cutter. The subject is a cast iron pump body, one end of which has to be faced. Owing to the form—see illustration—there are many interruptions, but chipping of the corners must be absolutely avoided.

A 5in. "Full Back" tungsten carbide cutter was used for the job and the cutting time, on 200 pieces, was eight



CAST IRON PUMP BODY

seconds per piece. The following comparisons are given:

(1) With a high-speed steel cutter operating at 80ft. per minute and a feed of 12in. per minute, the feed per tooth per revolution would be equivalent to 0·0165in.

(2) A Stellite cutter operating at 130ft. per minute with a feed of 21in. per minute would represent a feed of 0·0175in. per tooth per revolution.

(3) With tungsten carbide at 305ft. per minute and a feed of 32·5in. per minute the feed per tooth per revolution is only 0·014in.

The Stellite feed per minute is equal to an increase of 75 per cent. over high-speed steel. The tungsten carbide feed per minute is 170 per cent. faster than high-speed steel and 55 per cent. faster than Stellite, and owing to the very small feed per tooth per revolution chipping of the corners is avoided. If the depth of cut had been reduced to $^{9}/_{32}$in. the tungsten carbide feed could have been increased to 42·5in. per minute.

A VERY entertaining correspondence ha.., for a few weeks, been passing through *The Times* under the heading of "Famous Locomotives." One such letter referred to the exceptional single-wheel express locomotives of the Bristol and Exeter, which the writer of that particular letter said had 10ft. driving wheels. A subsequent correspondent wrote and corrected that and said the diameter was 9ft. He added that he thought it was "No. 2004" that was concerned in the Flax Bourton accident. We are prompted by that last remark to say that what was officially known as the Long Ashton derailment occurred on July 27th, 1876. The train was the up "Flying Dutchman" and the engine was "No. 2001" and had 8ft. 10in. diameter driving wheels, carrying an axle load of 18 tons 10 cwt. Both the enginemen were killed, but there were no serious injuries among the passengers. The origin of the accident was to be found in the fact that, in the previous year, the broad gauge was changed to mixed gauge, but as the longitudinal timbers were retained for the outer rails the intermediate rail required for standard-gauge trains created difficulties in maintenance, and Captain Tyler reported that "the offside rail rested loosely on the longitudinal timber and the timber loosely on the ballast."

WINNING, SPINNING AND WEAVING COIR FIBRE

(*For description see opposite page.*)

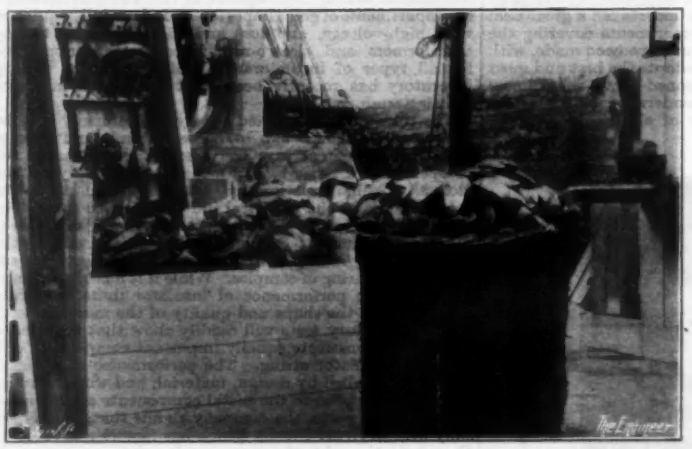


FIG. 1—RAW HUSKS ENTERING HUSK-PREPARING MACHINE

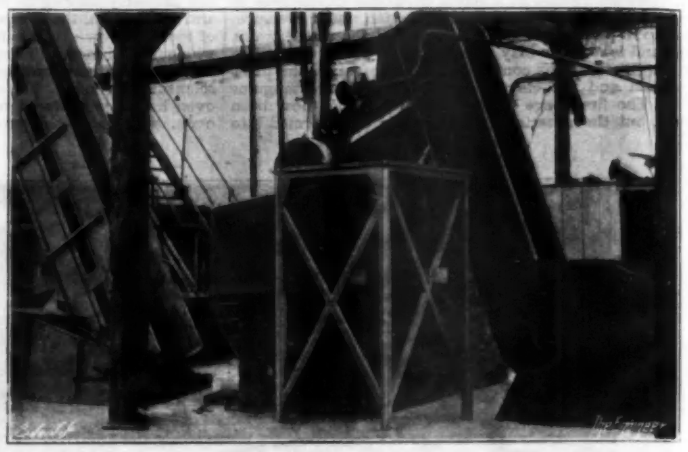


FIG. 2—HUSK-PREPARING MACHINE

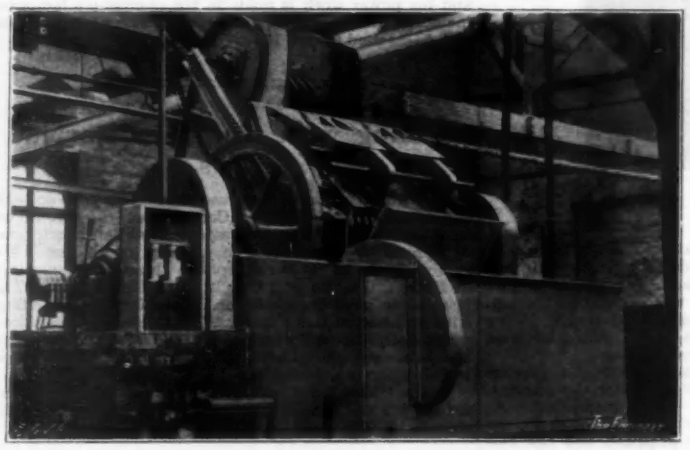


FIG. 3—HUSK-PREPARING MACHINE

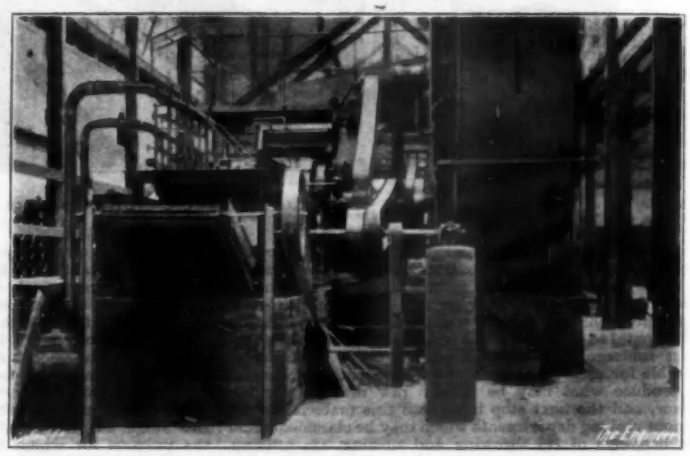


FIG. 4—HUSK BOILER, HUSK OPENER AND SQUEEZING MACHINE

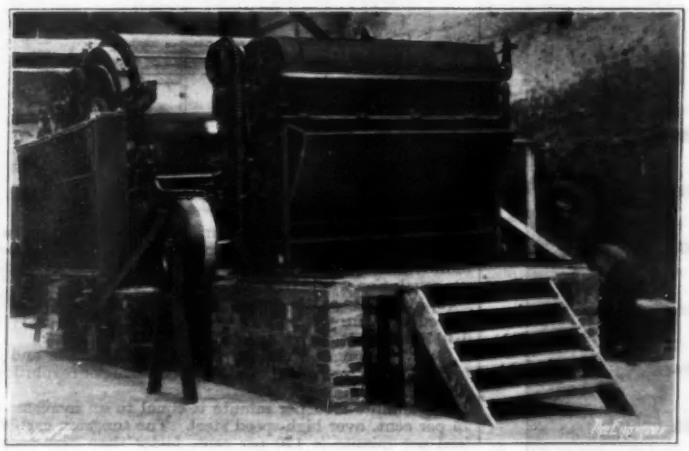


FIG. 5—AUTOMATIC GUIDER IN FRONT OF BREAKER CARD

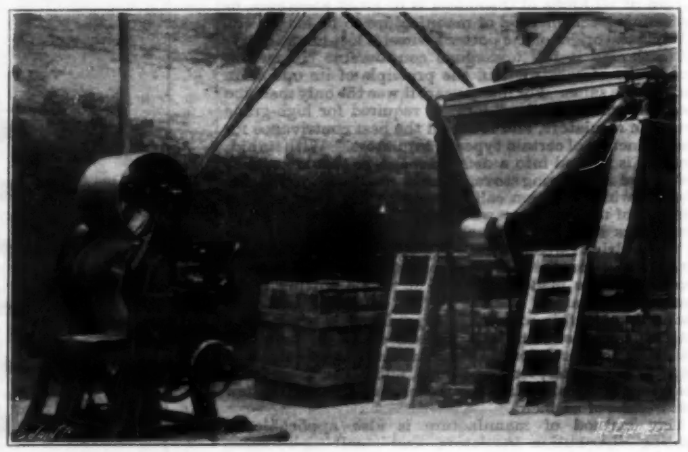


FIG. 6—DELIVERY END OF BREAKER CARD

FIG. 7—SLIVER ROLLS FEEDING FINISHER CARD

FIG. 8—VIEW OF DRAWING FRAME

Winning, Spinning and Weaving Coir Fibre.

AT present the possible yearly production of coir fibre for spinning is about 3·5 million tons. Actually only 100,000 tons are used, the remainder being wasted owing to the fact that no commercial use can be found for it. Coir fibre is hard and has an elasticity of about 30 per cent., whereas a similar figure for most other plant fibres is only 1 to 2 per cent., and its strength is equal to that of most grades of jute. It will withstand moisture and the action of many chemicals better than any other fibre, and is therefore particularly useful when such chemicals have to be transported in bags. Its resistance to the action of sea water is also very good.

The usual method of obtaining the fibre is to ret the husk of a not fully matured cocoanut in brackish water for a period varying from three to eighteen months, according to the conditions. During this process the coir dust loosens itself from the fibre, which is then cleaned by hand and spun, also by hand, into various kinds of yarn. Cheap and abundant labour is a necessity and ample space must be provided for retting. Only the husks of not fully matured cocoanuts can be used, and as it is rarely possible to win the copra from the flesh of the nut, the winning of the fibre is retarded by the requirements of the copra industry.

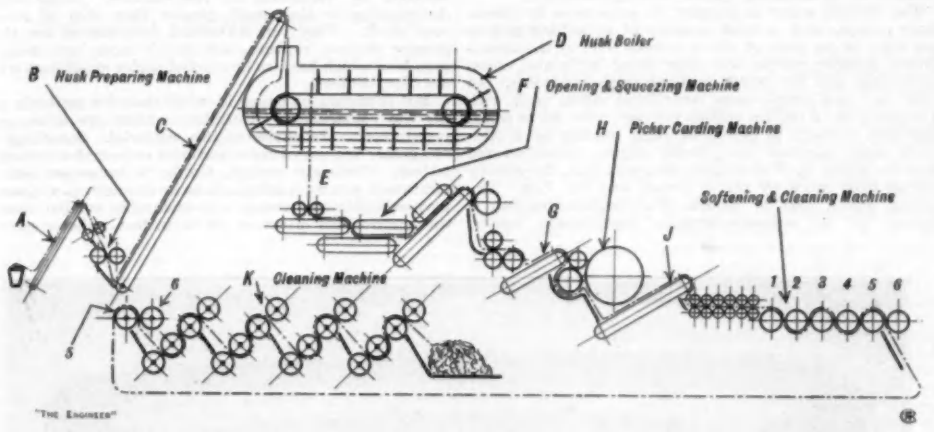


FIG. 9—DIAGRAM OF ARRANGEMENT OF INSTALLATION FOR PREPARING COIR FIBRE

To get over this difficulty, a new process has been invented by Mr. B. G. H. van der Jagt. This method renders it possible to extract the fibre from the husks of fully matured cocoanuts in less than two hours by mechanical means. The spinning of the fibre by machinery and the weaving of it in an ordinary loom into cloth is also covered by Mr. van der Jagt's patents. As the fibre can be obtained from the husks of fully matured cocoanuts, high-grade copra can be produced in the same factory, and the waste, the hard shell and the coir dust, can be burned in suction gas generators to provide power and heat for driving the machines. A most economical factory is therefore possible, and it is claimed that coir fabric and coir yarn will be the cheapest of all textiles in the future.

Fig. 9 is a schematic view of an experimental installation for preparing the fibre, which has been erected by Saint Frères, of Paris, the machinery being provided by Fairbairn, Lawson, Combe, Barbour, Ltd., of Leeds and Belfast. The raw husks are fed on to a conveyor A and opened in the husk-preparing machine B. A second conveyor C takes the opened husks to the bolier D in which revolves an endless chain, equipped with paddles, carrying the husks round with it in a weak solution of caustic soda raised to boiling point. The time during which the husks are boiled may be altered by varying the speed of the chain. After boiling the husks are soft and weak, and can be opened in the machine F, which also squeezes them. The opening is performed by pinned bars fitted on chains moving at different speeds, while at the end of the machine a pair of fluted rollers press the caustic soda out of the mass of fibre. The liquid can be used again for boiling fresh charges. A picker card H, specially constructed to work fibre more than 100 per cent. moist, reopens the pressed fibre and discharges it on to a conveyor J, which delivers it into a softener-cleaning machine, which, equipped with six pairs of fluted rollers, squeezes the last particles of coir dust from the fibre. Pinned rollers 1, 2, 3, 4, 5, and 6 open up the fibre again, and separate out the coir dust, the action being continued in the cleaning machine K, where the fibre passes through four sections of four rollers. After leaving the machine the mass is dried mechanically, and the fibre is softened and prepared for the mechanical spinning which follows.

Many difficulties had to be overcome before the preparing plant for the fibre could be run successfully. That is easily understandable when it is realised that the speed of transit of the fibre through the machines varies between 480in. per second and $^1/_{12}$in. in the same period. The "tuning" of the plant was therefore a lengthy process.

Before it is ready for the mechanical spinning process, the fibre passes through a mechanical drying machine and an ordinary jute softener.

As obtained in the foregoing manner, the coir fibre is well adapted for card feeding. At the delivery end of the breaker card there is an arrangement for subjecting the sliver to the heavy pressure which is found to be necessary to keep it together. The sliver is collected in four rolls, side by side on the same shaft, and fed into a finisher card. From the finisher card the slivers are worked over a set of drawing frames of the ordinary jute type, modified to suit the material, coming from the last of which they can be spun on a self-regulating gill spinner of the ordinary type, also modified for the purpose. Photographs illustrating the operations are reproduced on page 660.

Coir fibre made by this process can be spun without any difficulty into 48 lb. or 1 lea yarn, and it is believed that in the future still finer numbers will be obtained. It is possible, however, to weave this 1 lea yarn on a normal sacking loom into a very open fabric that looks, coming from the loom, more like a stiff matting than a pliable and closely woven cloth. When the "net" is moistened and passed through a hydraulic mangle, the round form of the yarn is transformed into flat ribbons, closing the holes and making a very pliable and neat-looking fabric, which can be used for making all kinds of sacking. It is claimed that it is particularly suitable for sacks for transporting artificial manures, because coir fibre withstands the action even of moist sulphate of ammonia very well. Coir yarn is suitable for the carpet industry, while, manufactured into ropes, it is particularly applicable to the fishing industry on account of the excellent resistance of the material to the action of sea water.

The cost of a complete installation, including the erection of buildings and bungalows for the employees, for working 5,000,000 cocoanuts a year would, we are informed, be about £40,000. It is estimated, however, that the profits would be considerable, while there are, it is believed, great possibilities of developing the industry in the Tropics.

Jinzoseki—An Artificial Stone.

(By our Correspondent in Japan.)

A COMPOSITE material, having the appearance and durability of granite, and costing much less, is being used extensively in Japan in the construction of large buildings. It is known as "Jinzoseki," or artificial stone, and free use is being made of it in the construction of our new Embassy buildings in Tokio, which are being erected under the general supervision of Mr. J. Cumming Wynnes, F.R.I.B.A., of H.M. Office of Works.

I am indebted to a Japanese engineer, Mr. S. Fukunaga, manager of the Konoike Gumi, the contractors building the Ambassador's residence, for the following description of the composition and use of this material.

"Artificial stone, which is called 'Jinzoseki' in the Japanese language, includes pre-cast blocks, and what is termed jinzoseki-nuri, or artificial stone coating, a finish made by coating with an artificial stone mixture. I cannot give the date when jinzoseki was first manufactured for building purposes, but, judging from the use made of it, I should think it had its origin in the desire to imitate granite. When Occidental architecture was first introduced, granite was considered to be the best and most ornamental of high-grade building materials. It was extensively used in such large buildings as the Bank of Japan (1882), the Akasaka Palace (1908)—noted for its resemblance to the palace at Versailles—and other large buildings. But not only is granite expensive, it is hard to work in carving or cutting mouldings without the aid of pneumatic tools. Something less expensive and more easily worked was desired, and jinzoseki made its appearance, and has gradually been widely adopted as a substitute for granite.

"There are several patented kinds of jinzoseki pre-cast blocks suitable for anchoring to the faces of walls. This imitation of granite is used in the building of the Japan Hypothec Bank—recently completed—and the new extension of the Imperial Library, each being faced with an imitation of *shirochoba*, a kind of andesite.

"The material of this artificial stone coating, extensively used as a finish for both the inside and outside of buildings, consists chiefly of cement and small chips of stone or granite. Portland cement, which, being greyish in shade, does not present a pleasing appearance, is mixed with a small quantity of lime to increase the effect of whiteness. According to the requirements of the architect, chips of granite, marble, and other kinds of stone may be used for colouration, white cement being used instead of lime when a high-class mixture is required. Jinzoseki attachment, which is a finish given to a concrete or lathed wall surface, is usually applied in two or three coats, the total thickness being about $\frac{3}{4}$in. The composition and thickness of the coating are shown herewith :—

Example I.

Material.	First coating, $\frac{1}{4}$in.	Second coating, $\frac{1}{4}$in.	Third coating.
Cement	1·00	1·00	—
River sand	3·00	0	—
Granite chip	0	2·00	—

Example II.: Mixed with Lime.

Material.	First coating, $\frac{1}{4}$in.	Second coating, $\frac{1}{4}$in.	Third coating.
Cement	1·00	1·00	1·00
Lime	0	·50	·50
River sand	3·00	2·00	0
Granite chip	0	0	1·50

Example III.: Used in the Ambassadorial and Other Residences of the New British Embassy.

Material.	First coating, $\frac{1}{4}$in.	Second coating, $\frac{1}{4}$in.	Third coating, $\frac{1}{4}$in.
Cement	1·00	1·00	0
White cement	0	0	·80
Lime	0	0	·20
River sand	2·50	2·50	0
Granite chip	0	0	1·00

"In the operation of coating the ground is first cleaned with a wire brush and a proper amount of moisture applied. The material of the first coating, mentioned above, is then applied, being pressed in strongly with a trowel, making clear joints wherever necessary. The joints are formed by fixing slips of wood, of the requisite width, temporarily, to the face of the first coating, and removing them after the finishing coatings have set hard. The deep joint thus formed is afterwards pointed with a dark cement.

"There are two methods of giving a finish to jinzoseki coating, namely, finish by washing and finish by polishing. In the former, the final coating is washed with an atomiser, at the proper time, before it is dry, being slightly rubbed with a brush, so that the stone chip may be partly visible on the surface where the cement is washed off. In finish by polishing, the final coating being adequately dry or hard, the surface is rubbed or polished with a sort of grindstone to impart a smooth finish. In this case, marble grain is generally used.

"Finish by washing is mostly applied to exteriors, and finish by polishing mainly for floors, bases, railings, dadoes, and other interior features.

"Jinzoseki, which is softer than natural stone, has naturally less tolerance. In artificial stone we cannot expect the exquisite colouring or tone that is to be obtained from the various kinds of natural stone, but jinzoseki has points of advantage over the natural product, which may be listed as follow :—

(1) Elaborate form is more easily obtainable with jinzoseki than with natural stone.

(2) Jinzoseki is cheaper as raw material and less expensive in further manufacturing processes, i.e., for ornamental uses.

(3) Jinzoseki has greater power of resistance to defacement than natural stone, its strength in this respect depending upon the method of handling it.

(4) In fire, jinzoseki is less brittle than natural granite, and therefore affords better protection to the main concrete body.

"This latter quality was amply demonstrated during the great fires that ravaged the city in September, 1923. Among Japanese architects and builders it is considered a matter of great interest that jinzoseki should be used in the construction of the British Embassy, since architects are not yet in agreement as to its value as a facing material. For years past the question of the best sort of finish for a concrete building has been a subject of study, and every means possible are being tried to improve jinzoseki, as well as similar building material, with the object of increasing its efficiency."

B.E.S.A. Specifications.

All B.E.S.A. Specifications can be obtained from the Publications Department of the Association at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

BRAZING SOLDER.

The British Engineering Standards Association has recently published a revised issue of the British Standard Specification No. 263 for Brazing Solder. This new edition has been prepared in order that an addition grade, intended primarily for solder supplied in the form of slittings and wire, might be incorporated. This grade is designated A A, and the three grades now covered by the specification are accordingly A A, A and B. Another point of difference between the new issue and the one superseded is that the dimensions of certain of the sieves for testing granular solder have been modified so that they may be in exact agreement with the dimensions in the recently published British Standard Specification for Test Sieves—No. 410.

ALUMINIUM ALLOY SHEETS AND STRIP.

A further specification relating to wrought aluminium alloys for general engineering purposes has recently been published by the British Engineering Standards Association. It relates to heat-treated sheets and strips, and covers the alloy generally known as Y alloy. It is drawn up on parallel lines to the B.S.S. No. 395, which covers the alloy known as duralumin, with suitably-modified test requirements. The chemical composition of the material, the tolerances permissible on the finished sheets and strip, and the tensile strength, proof stress, and elongation are specified. Appended to the specification is a useful memorandum dealing with the preparation and heat-treatment of the alloy.

EBONITE.

The British Engineering Standards Association has recently issued a revision of British Standard Specification No. 234—Ebonite for Electrical Purposes. This new edition is an extension of the original—1925—specification, which provided only for ebonite panels for radio purposes, and covered only one grade of ebonite. In the new edition, however, the scope has been widened to cover pure non-loaded ebonite in the form of sheets, rods or tubes suitable for electrical purposes, including radio apparatus. Two grades of ebonite are now included, one of these being similar to that covered by the old specification, and the other grade having superior electrical and mechanical properties, this grade being intended for use where the highest quality material is required.

The majority of the methods of test are similar to those in the old specification, but in one or two cases the description has been amplified and recommendations are given for a method of detecting metallic particles in ebonite to be used for high-frequency high-voltage work.

A New Form of Suspension Hook.

THE need for some flexible and adaptable form of suspension hook is apparent in almost every industry, particularly when materials have to be suspended from sections of structural steel work. Shuttering for concrete work, pipe lines, scaffolding, telephone lines and power cables, whenever appliances of that nature have had to be supported, it has been necessary either to resort to what is known as a "lash up," with wire or tarred string, or to go to the expense of making iron cleats with suspension holes, to fit the steel work. These difficulties have been intensified in such places as coal mines and subways where electric cables have to be supported from the arched girders which carry the roof, and the work of hanging

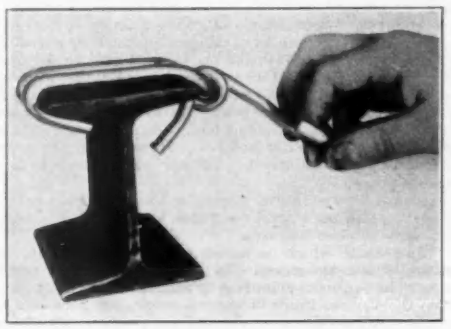
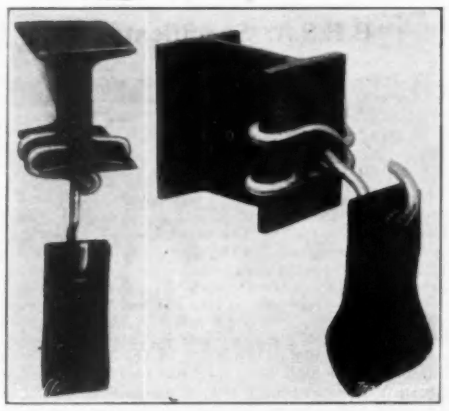


FIG. 1—"TALON" SELF-LOCKING SUSPENSION HOOK

the cables has had to be done very often in almost total darkness. An appliance which it is claimed has effectively solved this problem is the "Talon" self-locking suspension hook, of which, we are informed, many are already in use for supporting electric cables and pipe lines in coal mines. "Talon" galvanised steel hooks are made in two forms, known as the top and bottom types respectively. The top type, as its name implies, is made for fitting on the top of steel joists and, as shown in Fig. 1, it can easily be fitted or removed with one hand without the use of any tools. This type of hook, it is pointed out, makes the maximum use of the available height, as cables or pipes can be made to sit close to the underside of the joists from which they are hung. The bottom type of "Talon" hook, shown in Fig. 2, can be slipped over the bottom or open flanges of a joist with the same facility as the top type. It will support cables or pipes from beams fixed at any angle, and, as shown in Fig. 3, will even lock itself in position on a vertical flange, additional weight only serving to tighten the grip. These fittings are of



FIGS. 2 AND 3—BOTTOM TYPE OF "TALON" HOOK

all-British production, and can be made for any section of joist. They are being marketed by Messrs. A. B. Steele, of Reculver-road, Beltinge, Herne Bay, Kent. Patents have been applied for in connection with them.

Shanghai Waterworks.

WE have received from Mr. C. D. Pearson, M. Inst. C.E., M.I. Mech. E., who is engineer-in-chief and manager of the Shanghai Waterworks Company, the following notes regarding the recent activities of his company. The company, it may be explained, is a British concern, and it has been in existence for over fifty years.

The company's consumers number, at present, about one million, the majority of whom reside in the International Settlement. In 1905, the average daily output was only 4,880,000 gallons, but by 1930 the daily average had risen to 39,233,000 gallons, with a maximum daily of 53,497,000 gallons and a maximum hourly of 3,581,000 gallons.

The source of supply is a turbid and tidal tributary of the Yangtszekiang, which is, necessarily, polluted by the run-off from the highly cultivated alluvial plain through which it flows. To be able to treat such water so that, when delivered to consumers, it will comply with the bacteriological standard laid down—lactose fermenters not to exceed 10 per litre—naturally requires a carefully designed and operated plant. The water, after preliminary treatment with a coagulant—sulphate of alumina—in continuous settling basins, is passed to slow sand filters, or pumped to rapid gravity filters, the operating floor of one battery of eight filters—which has a daily capacity of 24 million gallons—being shown in the accompanying illustration. A second battery of the same size and with an output of 24 million gallons daily, was constructed in 1930, four filters being then put into operation, the remainder having been equipped this year. These filters—the "Larner-Johnson," valves for which were provided by J. Blakeborough and Sons, Ltd., of Brighouse, Yorks.—are to the designs of the company's engineer-in-chief. To relieve the filters, prechlorination is employed, and, after filtration, the water is again chlorinated.

The water is raised, first, from the river to the settling basins and thence to filters by single-stage centrifugal pumps driven by electric motors or oil engines. During 1930 one pump, with a capacity of 1,000,000 gallons per hour, which was manufactured by W. H. Allen, Sons and Co., Ltd., of Bedford, and is driven by a Crompton-Parkinson auto-synchronous motor, and also two half-million-gallon per hour pumps driven by two solid injection four-cycle engines—also by Messrs. Allen—were installed. Further additions to the low-lift plant are now being made and the company's policy—rendered advisable by local conditions—of dividing the load between electricity, coal and oil, as the motive power, is being continued.

The filtered water is pumped to consumers by eleven main pumps, with a total capacity of 4¾ million gallons per hour, 58 per cent. of which is dealt with by the steam-driven plunger pumps, the older being horizontal cross-compound and the newer vertical triple-expansion. In 1930 two new single-stage centrifugal units, each with a capacity of 15 million gallons per day, were set to work. The first of them is driven through gearing by a two-cycle solid injection six-cylinder engine, manufactured with the pump, by Worthington-Simpson, Ltd., the gearing having been made by David Brown and Co., Ltd. The second pump, also by Messrs. Worthington-Simpson, is driven by an auto-synchronous high-tension motor,

OPERATING FLOOR OF RAPID FILTER HOUSE AT SHANGHAI

designed for 0·8 leading power factor and supplied by the British Thomson-Houston Company, Ltd. These sets, as is the company's normal practice, were erected and tested by the company's staff.

In 1930 orders were placed with Guest, Keen and with Piggotts for the steel pipe, bends, &c., and with Messrs. Glenfield and Kennedy for the valves, which were required for 4 miles of 40in. diameter pumping main. The laying of these pipes is at present being carried out by the company's staff, which is also wrapping the pipes on site after delivery.

Other works carried out during the last twelve months included (*a*) an additional intake tower with revolving hydraulically-cleared screens of 4 million gallons per hour capacity; (*b*) 3000 kW, 6000-volt sub-station switchgear manufactured by A. Reyrolle and Co., Ltd.; (*c*) an installation of oil filters by the Streamline Filter Company; (*d*) a steam desuperheater to enable high-pressure and highly superheated steam from modern Babcock and Wilcox boilers to be used on the older part of the plant, and (*e*) the usual mains extensions, new buildings, &c., required by an undertaking coping with a demand increasing by 8 per cent. annually.

The provisional sanction of the municipal authority, under a franchise from which the company operates, has been obtained for the supply of water by meter for domestic, as well as, as at present, for industrial, purposes, and it is expected that installation of these meters will be begun towards the end of this year.

Reinforced Concrete Bridges.*

By T. J. GUERITTE, M.I. Struct. E.

REINFORCED concrete is the most suitable material for the realisation of great spans, superior even to the best wires for suspension bridges, the working stress of which is at best two-fifth of the breaking stress, whereas the working stress of transversely reinforced concrete greatly exceeds the breaking stress of concrete.

For very great spans the ideal solution from an economical point of view is an arch rather than a girder, since one saves one flange and the diagonal members.

In the construction of concrete or reinforced concrete arches of great span, the question of the center plays a most important part, not only as regards the design, but also as regards cost. It may be said that the cost of the temporary work for important spans, which has been too often unduly high, because sufficient attention has not been paid to its design, has proved to be one of the causes of the comparatively slow rate of increase in the span of reinforced concrete bridges so far. This question had to receive careful consideration in the case of the reinforced concrete viaduct at Elorn-Plougastel, the main part of which consists of three spans, 567ft. each in the clear.

Monsieur Freyssinet points out that various engineers have advised the use of centers either metallic or in reinforced concrete, the arched part of which could be incorporated into a permanent reinforced structure. But this would be useful only were it possible to reduce thereby the maximum stresses, in the completed structure. But in practice this cannot be realised, therefore Monsieur Freyssinet adhered to his previous practice of using timber centers, which are generally much cheaper than metallic ones and lighter, lending themselves consequently to greater spans, while being considerably less affected by variations of temperature. Their elastic deformation is also much greater than that of riveted steel work. They can withstand deformation ten times greater without rupture, and this is most important for members which have to be erected under conditions which are often difficult.

But it should be borne in mind that the methods used for the construction of timber centers are often quite unsuitable to the nature of this material. Scantlings are too great; the use of bolts and butt ends or short scarfings is bad. Curiously enough, timber is somewhat akin to reinforced concrete, inasmuch as its strength in a direction perpendicular to stresses is considerably smaller than in the longitudinal direction; it is, in fact, a heterogeneous material composed of cellulose fibres connected by a weak agglutinant.

Consequently, just as in the case of reinforced concrete, the jointing surfaces of the longitudinal reinforcement must be very long, and the constituting elements must be numerous and of small scantling. At Plougastel, the flanges of the center were constructed with 3in. by 8in. battens on edge, on the top of which were nailed two thicknesses of 1¼in. boarding at 45 deg. in both directions—to guard against shear. Nails only were used for the joints, the heaviest being ¾in. in diameter, with a length of 14in. The ends of consecutive battens—in the longitudinal direction—did not butt against each other; on the contrary, a certain space was provided which, after construction of the center, was filled with cement paste. The center which was used in succession for the three arches was erected on the shore, the two ends having been placed on reinforced concrete pontoons, the center was towed to the site of the first arch to be built and fixed in position. After concreting of the first arch, it was removed bodily and brought to the second span, and later on was similarly brought to the third span. Every detail of this operation was properly worked out beforehand; the whole thing went like clockwork, each shifting taking between two and three hours. Monsieur Freyssinet would have no hesitation in applying similar methods to the construction of arches having spans of 1500ft. to 2000ft. or even more, and considers that with good rock foundations, a span of 3270ft. could be realised in concrete. The cost would be approximately half that of the suspension bridge now under consideration for crossing the Hudson, and the risk much less.

The main point is that structural steel work of the type used in arches, working in compression and with an elastic limit of, say, 36,000 lb. per square inch, would weigh approximately 33 lb. per foot run for every 100 tons which it could carry without buckling. To transmit the same load of 100 tons, a concrete member of the same quality as that forming the arches of Plougastel—that is, having a crushing strength of 8500 lb. per square inch—would weigh less than 27 lb. per foot run. Also the cost of 1 ton of concrete is hardly one-fifth of the cost of 1 ton of structural steel work.

It is known that concrete of better quality than that of Plougastel can be made in bridge work; consequently, the advantage of concrete over steel can be increased still further. The weight of a reinforced concrete arch of great span would be hardly half that of the equivalent steel arch and the cost considerably lower. Looking at the

* Abstract of a paper read before a joint meeting of the Institution of Structural Engineers and the British Section of the Société des Ingénieurs Civils de France, April 23rd, 1931.

matter from a practical point of view, Monsieur Freyssinet has calculated from the law of similitude the stresses which would occur in bridges of the Plougastel tubular type and of spans respectively 1635ft., 3270ft., and 4900ft. They are quite reasonable. In fact, the only consideration limiting the span of such bridges is that relating to the center. Studying, therefore, the construction of the center, and assuming that no intermediate support is available, he finds that the construction of centers similar to the Plougastel one, would be limited for practical as well as financial reasons to a maximum of about 6000ft.

At present-day prices, the bridge supposed to be founded on rock would cost less than half what is foreseen for the Hudson suspension bridge of the same span, and with twice as great a factor of safety. The Hudson scheme foresees a working stress of 82,250 lb. per square inch for wire steel breaking at 218,400, as compared with the Delaware Bridge, where the working stress was limited to 72,300 lb. per square inch for steel breaking at 217,700.

American Engineering News.

Mechanical Puddling.

After extensive experimental work with a small plant, a commercial plant with a capacity of producing 50,000 tons per month, has been put in operation in America for the manufacture of pure wrought iron by the Byers process, which is essentially a mechanical puddling process. In this new American development, pig iron is melted in a cupola and the molten metal then refined in a Bessemer converter. The resulting highly refined iron is carried in ladles to a platform fitted with cups or vessels containing slag of a very exact and specific analysis, which has been prepared in an open-hearth furnace and tapped into the cups. As the molten iron is poured into the cups and falls through this liquid slag, it solidifies into a granular form, and each grain acquires a coating of slag. In fact, each grain is at first globular and encloses gas which finally bursts the grain and thus causes it to be completely coated with slag. After sufficient iron has been poured the surplus slag is decanted, leaving a ball of iron in the bottom of the vessel. But this ball weighs 6000 lb. to 8000 lb., while in the hand-operated puddling furnace the ball weighs about 200 lb. The new process permits of very close chemical and metallurgical control, without limit as to quantity and without requiring heavy manual labour. Owing to the great size and weight of the mass of iron powerful machinery is required to reduce it to commercial material. The new wrought iron plant includes a 900-ton press for producing blooms about 17in. by 24in. in section, a 40in. blooming mill for billets and slabs, a universal plate mill adapted for rolling plates 2ft. to 7ft. in width, a skelp mill, and a merchant mill for rolling billets into flat, round and square bars and other shapes. For burning out the various elements contained in the molten iron as it comes from the cupola, there are two Bessemer converters, each of 10 tons capacity.

Brick Paving.

Although concrete has largely superseded brick for highway paving, and to some extent for street paving, there is still a considerable amount of paving brick laid on both roads and streets in America. While the hard-burned vitrified brick is satisfactory as to strength and wearing properties, it depends largely upon its base course for permanence and smoothness. Concrete being the usual base material, discussions on brick paving centre considerably on concrete design and construction. In general, there is a sand cushion or layer between the concrete and the brick, but the slightest voids in the joints or the slightest entrance of water at joints is likely to cause the sand to shift or creep and so cause an uneven support for individual bricks. For this reason there is increasing use of oil sand and cement sand mixtures, which are more stable and also of granulated slag, which is a self-cementing material. A novel construction now in experimental use consists of a steel plate sheet or blanket instead of concrete. This is said to be giving good results, but its cost is relatively high. As used on a country road, different arrangements of flat and corrugated plates have been laid, lapped at the joints and having an angle iron welded along the outer edge as a kerb to hold the bricks in place. Some plates also have an angle on the underside to form an anchor in the earth and prevent shifting of the plates. Instead of sand, a mastic coating is used in which the bricks are bedded. At one time cement grout was used to fill the joints, but the more general practice nowadays is to pour in hot asphalt or bituminous compositions. But there is difficulty in getting a composition that will flow so easily as to thoroughly fill the joints, but will not soften and "bleed" in warm weather. In city streets concrete and crushed stone are mainly used for the base course, the former especially in streets of heavy traffic.

Factory Without Windows.

A new manufacturing building completed recently for the Simonds Saw Company at Fitchburg is unique in having solid walls and depending entirely upon artificial lighting. The building is 360ft. by 500ft. in plan, of steel-frame construction and designed greatly to reduce the usual noises from machinery and factory operation. The lighting system consists of 1000-watt lamps 18ft. above the floor and fitted with steel diffusing shades so as to give a uniform light intensity of 20 foot-candles at the working level over the entire area of the building. A small proportion of the light will be directed upon the ceiling, for the sake of pleasant appearance as well as to assist in the general diffusion of light. Temperature control and air conditioning apparatus is provided to ensure clean air, comfortable temperature and a normal degree of humidity. The walls are of porous cinder concrete blocks, for acoustic purposes, with an exterior facing of brick. The roof, which has no skylights, consists of 1¼in. of asphaltic concrete on metal sheathing, with two layers of ½in. insulating board laid in asphalt and covered with waterproof roofing. The heated or cooled air is to be delivered at the rate of 500,000 cubic feet every ten minutes, temperature being regulated automatically by thermostatic control, and special care being taken to ensure a slow and steady movement of the air without unpleasant draughts. Wood blocks on concrete form the floor and all large machines have insulating pads in the foundations, while the foundations are isolated to prevent the spread of vibrations. A special colour scheme has also been worked out, in which the machines will be painted orange as an aid to the visibility of the parts and consequently an aid to safety in operation. A combination of green, blue and white is used for the walls and ceiling; the green for general tone, white for clean and cheerful appearance and blue to reflect ultra-violet rays of the lamps.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Quiet Times.

THESE are quiet times for the iron and steel trades and the heavy engineering industries of the Midlands and Staffordshire. Perhaps never before has this district, with its variety of trades, been more in need of a business tonic. Right throughout the length and breadth of the area there is idle plant. Activities everywhere are of a restricted character, and manufacturers and producers of raw materials have been compelled by the persistent trade depression to reduce *personnel*, having in many instances had to dispense with the services of valuable mechanics who have been many years on their staff. Most works continue to function more or less, but industry generally hereabouts lacks a steady momentum. Most branches of engineering experience a shortage of orders, especially in the heavy sections. There are a few Midland constructional engineers who are doing better just now than they were a month or two back, the building or improvement of highways, the reconstruction of bridges and interior girder work for places of amusement and the like providing them with work. The industry on the whole, however, is poorly engaged. Local rolling stock establishments, in common with constructional engineers, find British railway contracts cut down to the lowest limits. Boilermakers, producers of tubes, of nuts and bolts, of fencing and of heavy edge tools are all working much below capacity, though here and there firms in the latter trade which have concentrated on tools for the home market are fairly well situated. Of the miscellaneous metal manufacturers in which this district teems, few are making anything like an average turnover. Machine tool makers whose activity usually affords a gauge as to the state of affairs in the finishing branches of Midland industries, report that present orders are mostly for odd tools to replace others now obsolete. They are getting hardly any orders for complete installations. In these days of up-to-date methods and machinery, the trade depression must be bad indeed when machine tool makers are compelled, as they are at present, to curtail employment. The past week has provided no evidences of improving demand or of any reinvigoration of trade in this area. Moreover, it is practically impossible to speak with encouragement of the immediate future. No one seems willing even to hazard a guess as to when an improvement may be looked for. On 'Change in Birmingham this week very little business was transacted. Demand for iron and steel is dominated by current consumptive requirements, users not being prepared either to buy for stock or to place contracts in the present unsettled state of the market and unstable condition of trade. The position in this area is grave.

Brief Iron Improvement.

The improved buying of pig iron which followed the reduction in selling prices, and which I commented upon last week has not been maintained. Foundrymen appear to have made up their reserves, which had been allowed to fall to a very low level, and this having been accomplished, demand became as sluggish as it was before. It is evident that there was no improvement of consumption behind the movement, which, failing to find support from consumers, rapidly fizzled out. Those who had been cheered by the hope of a steady development in trade have, at any rate for the present, been disappointed. It is still possible that Midland blast-furnacemen, and in particular those in Northamptonshire, may have gained some return of business recently diverted to the foreigner, while they are also likely to acquire a larger portion of foundrymen's orders when they are available. There are plentiful stocks of all brands of Midland pig iron, and users experience no difficulty in obtaining early delivery. The pipe foundries continue to consume a large share of Derbyshire iron, and smelters are generally able to find an outlet for most of the iron remaining. Northamptonshire iron is still on offer in Northern markets at competitive prices. Foundry iron—No. 3—of Derbyshire or North Staffordshire make is quoted £3 6s. per ton for delivery in the Black Country zone. Northamptonshire material is £3 2s. 6d. Forge grade command £3 1s. and £2 17s. 6d. respectively.

Steel Values.

It is evident that other users of finished steel besides those in the shipbuilding industries, who have recently voiced their complaint, consider that British steel prices are too high. Engineer users in this area have during the week made reference to this matter, stating that while they have not made any formal protest, they have long since given steelmasters to understand that they considered the range of prices fixed by the Steel Association to be unduly inflated, and that the situation is not met by the rebates offered to consumers confining themselves to British steel. Periodically, the steelmasters review the position, and they will undoubtedly pay attention when they next meet to the grumbles of users, but whether they will decide that it is possible for them to do anything further towards decreasing the handicap of British engineers in competition with those of other countries, which forms the basis of users' present complaints, is an open question. Just now there is very little call for steel, either finished or semi-finished, most of the consuming works in this district being poorly engaged. Right throughout the whole range of steels orders are for small tonnages, just sufficient for current needs. In the finished branches values are firmly held on the basis laid down by the associated makers, while in the half-products department prices are weak. Small bars re-rolled from continental billets this week sold at £6 10s. per ton, while all-British bars were to be had at £7. Mild steel billets were named £5 and upwards delivered. Continental prices continue low, but Midland merchants are reported to be doing very little business.

Staffordshire Iron Trade.

There is no improvement on the week in the Staffordshire finished iron trade, and the market affords no feature of interest. Mills whether engaged in the production of best, merchant, or common grade bars are all affected by the depression, and operations only extend to two or three days in the week. There is a general shortage of orders and a lack of forward business. Marked bars are quoted £12 per ton at makers' works; Crown bars vary from £9 5s. to £10 7s. 6d.; nut and bolt iron is offered at as low as £8 10s.; but iron strip is upheld at £10 17s. 6d. delivered. There is no easing in Belgian competition in the common bar department.

Galvanised Sheets.

The galvanised sheet market has relapsed into inactivity. There was a brief spell of buying following the decontrol of prices, but it was quickly over. Mills in this district are not, generally speaking, much better off for business now than they were before. Having satisfied their immediate requirements, both home and foreign consumers are content to await the time when a renewal of supplies will become imperative. Though the quotation for galvanised corrugated sheets of 24 gauge remains at £10 5s., report has it that lower prices have been accepted in this district this week. Efforts to confirm this rumour have, however, failed. Consumption of black sheets by motor car engineering firms is reasonably good. Business is done on the same terms as have applied during recent weeks.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Textile Machinery Merger.

No further public statement has yet been issued regarding the proposed merger of Lancashire textile machinery manufacturers, an announcement concerning which was made towards the end of last month. Up to the present six firms are embraced in the scheme—Platt Bros., Oldham; Dobson and Barlow, Bolton; John Hetherington and Sons, Manchester; Howard and Bullough, Accrington; Brooks and Doxey (1920), Ltd., Manchester, and Asa Lees and Co., Oldham—and it is understood that progress is being made in working out the financial details. Interest was aroused at the time by the omission from the group of the name of Tweedales and Smalley, Ltd., Rochdale. Not a great deal of information was forthcoming on the matter at the annual meeting of that company, although Alderman W. Davidson, the chairman, stated that the proposal to join the merger had been put before the members of the board, who had come to the conclusion that the scheme did not fit in with the position of the company, whose interests, it was felt, would best be served by remaining as they were. This, also, was the opinion of the general body of shareholders, who unanimously approved of the directors' decision.

Electricity's Field.

A development of the demonstration of electrical appliances for domestic purposes is the demonstration of industrial plant whose source of power or heating is electricity. An interesting step in this direction has been taken by the Electricity Department of Manchester Corporation. In co-operation with engineering concerns in the electrical field, demonstrations of electrical processes and operations will be carried out for the benefit of industrial firms in a special demonstration workshop, which has been opened here by the Department this week. For a period the stage will be occupied by the Metropolitan-Vickers Electrical Company, of Trafford Park, Manchester, arc welding being the attraction. A feature which should make a direct appeal is that the demonstrators undertake to tackle any special problems in the arc welding field that individual manufacturers care to put forward. Case-hardening and carbonising are other specialised branches which will come under notice later. The possibilities of lasting benefit to the producer of electric current, to the electrical engineering industry, and to the user of electrical plant and appliances can readily be seen.

Industrial Results.

A satisfactory showing is made by the accounts of West's Gas Improvements, Ltd., Manchester, for the year to the end of March, the profit amounting to £37,421, and the dividends on the preference and the ordinary share capital being maintained at the same rate as in the previous financial year. No detailed financial statement has yet been issued by the directors of Mirrlees, Bickerton and Day, Ltd., oil engine manufacturers, Hazel-grove, Stockport, although the announcement that no dividend will be paid on the ordinary shares for the year to the end of March last, compared with 7 per cent. in each of the two previous years, points to less satisfactory results. The dividend on the preference shares has, however, been paid. The past year's operations of the Broughton Copper Company, Ltd., Manchester, have resulted in a net loss of £35,608, which, with the help of £8000 taken from the reserves and the sum of £250 brought forward, is reduced to £27,358. This compares with a profit of £14,660 in the previous year and one of £59,857 in 1928–29. The preference dividend is in arrear as from the second half of 1929–30.

Non-ferrous Metals.

The non-ferrous metals have again passed through a critical week, although, in each case, there has been a recovery from the worst, with, on balance, a very slight improvement in both copper and tin, and a more important improvement in spelter, lead having just got back to the price current a week ago. Adverse American influences, largely of a statistical nature, made their influence felt on copper, standard brands at one time falling to the lowest value ever recorded. This did not last for long, however, steady buying on the fall, principally by speculative interests, and some degree of improvement in reports from the United States, serving to swing the pendulum in the other direction. Eventually, quotations attained about 2s. 6d. a ton higher than at last report, with, however, the demand for industrial uses on no more than moderate lines. Tin sales have also been quiet, and the supply position of the metal is still decidedly top-heavy, a further formidable increase having been recorded. Here, again, there has been some resistance and prices are higher on balance by a shilling or two a ton. The movement of lead has been restricted in almost all consuming directions, and at one time pronounced weakness was in evidence, although the loss was eventually wiped out. In the spelter market, some hope of a better industrial demand and of effective curtailment of production has strengthened values, and a gain of nearly 10s. a ton on balance has been registered.

Iron and Steel.

Conditions in the iron and steel markets this week have been almost hum-drum in character. Occasionally sellers of foundry iron report moderate bookings, but for the most part trade has been limited to small parcels, with cheap scrap still upsetting sales of foundry. Prices are at 67s. per ton for Derbyshire, Staffordshire and Cleveland makes, 65s. 6d. for Northants, 88s. 6d. for Scottish, and 81s. 6d. for West Coast hematite, all delivered equal to Manchester. Lancashire Crown bars are quoted at £9 15s. and No. 2 material at about £8 5s., but the demand is poor. Heavy steel users in Lancashire in almost every instance are buying from hand-to-mouth, and unsatisfactory order books appear to be the general rule, structural firms and locomotive engineers being particularly affected in this respect among the bulk users. Growing uncertainty as to prices is another factor to create an effective barrier between steel rollers and forward contracts. Small bars are offered at about £6 15s. per ton, and acid and basic boiler plates at from £8 17s. 6d. to £9, according to quantity. Other materials are maintained at £8 7s. 6d. for sections, £8 15s. for joists, £8 17s. 6d. for tank plates, and £9 7s. 6d. for 3in. and upward bars.

BARROW-IN-FURNESS.

Hematite.

The market has weakened in more than one respect, and the most outstanding evidence of the fact is the coming down of prices to the extent of 2s. per ton. The falling off in the local demand for iron on steel account has resulted in a curtailment of output, and two furnaces at Barrow are damped down for the time being. Business is thin all round, and if there is any district buying on a bigger scale than any other it is the Midlands. Scotland and Wales are not taking much. The continental requirements are low, and America is a poor customer at present. There is also keen competition in the market and foreign pig iron has found customers. At present there is no sign of an improvement, and with stocks standing as high as they do, makers will not be keen to add to the already big figure. Iron ore is flat in view of restrictions by iron smelters and the outlook is not reassuring. The steel market is very quiet, and although there are some prospects of further contracts makers are experiencing difficulty in keeping their mills working in Cumberland. The Barrow mills are idle.

SHEFFIELD.

(From our own Correspondent.)

Depression Deepening.

THE production of steel in this district goes on declining, a state of things which is particularly noticeable in the open-hearth department, which produces material for engineering and general commercial purposes. Official figures are now available of the output of ingots and castings during April. They show that in the Sheffield area the total was 46,500 tons, as compared with 69,500 tons in March, and 86,800 tons in April last year. Included in the total were 15,000 tons of acid steel and 26,600 tons of basic. Large as was the precentage drop in this immediate district, it was still larger in North Lincolnshire, where the April output was only 20,500 tons, the smallest monthly figure recorded since the war. The quantity produced in March was 36,500 tons, while that of April last year was 63,100 tons. In April, Lincolnshire produced 29,900 tons of basic pig iron, comparing with 40,300 tons in March, and no less than 72,300 tons in April of 1930.

The Experience of Park Gate.

Mr. Douglas Vickers, chairman of the Park Gate Iron and Steel Company, at the annual meeting of the company last week, gave some interesting details with regard to the decline in the steel trade, and the handicaps which it has to face. As I have previously mentioned, the directors' report showed that the output of steel ingots during the twelve months ended March last was only 72 per cent. of that of the preceding year. Mr. Vickers gave the actual figures. He said that in the year 1929–30 the output was 179,990 tons, or 90 per cent. of capacity; whereas in 1930–31 it was only 129,040 tons, or 64½ per cent. of capacity. If output had been the same, costs could have been reduced 12s. 6d. per ton and the gross profit would have been £107,500 instead of £33,000. Billets and other forms of rough steel, he said, were allowed to come into this country and reduce the foreign makers' costs by allowing them to work nearly full time. Our costs were increased by 50 per cent. when only half time was worked. Then politicians and others were surprised that the steel trade could not make a profit, and imputed inefficiency and all sorts of things that were absolutely unjustifiable. Mr. Vickers also spoke of the exceptional facilities which Park Gate possessed for dealing with trade when it improved, and mentioned that although part of the scheme of works development had been completed and had proved of distinct value, expenditure had been deferred owing to the dropping away of trade.

Present Production.

There is no improvement to report in the present condition of the open-hearth department, nor any sign that one is in early prospect. At the great Templeborough works of the United Steel Companies, there are still only five furnaces in commission out of a total of fourteen, while at the Ickles one furnace out of eight is engaged on the production of acid steel. Other plants are running to a similarly limited extent. The total number of furnaces at work in the district has probably never been so low before. Not only so, but it is increasingly difficult to find a market for the output, restricted though that is. There is a fairly regular flow of orders which are just sufficient to keep the plants going, but they are of small dimensions, and there is such a marked absence of weight about both orders and inquiries that it is impossible to see a continuance of operations for more than a week or two ahead. There is little activity in the market for scrap. The top price for basic material is 40s., as against 60s. a year ago, and nearly 70s. in the previous year. A good deal of stocktaking is in progress, and there is not likely to be any increase in the quantities of scrap required by merchants or steel makers this month.

Manufactured Steel.

There is still an absence of important contracts in the heavy engineering works, but comparatively good employment is to be found in the branch concerned with the production of heavy hollow forgings, which is booking a fair number of orders for boiler drums for large power plants in different parts of the country. Another bright spot—perhaps the brightest in the whole trade picture at the moment—is that of stainless, heat-resisting, and acid-resisting steels, producion of which continues at a substantial level, though there has been a lull in the expansion of the trade. For shipbuilding steel and shipyard requirements generally, the call is still very poor. The demands of the railway companies are on a scale almost as small, and the shops devoted to the production of axles, tires, and springs are very short of work. A good deal of employment is afforded by the needs of the automobile industry for forgings, pressings, and alloy steel, but there has been a considerable falling off in this trade of late, and firms which depend largely upon it are feeling a serious difference. The file and saw trades are slack. No recovery can be reported in the overseas demand for tool steel and tools, and the home trade in these important products remains but moderate. On the whole, it is to be feared that local trade has lost ground since the Whitsuntide stoppage. A considerable number of the workers who were suspended for that holiday have not been reabsorbed, while some of those who have gone back are only working short time. The total number of unemployed in the city has now reached 60,559.

Sheffield and Tramway Material.

Special trackwork for a tramway car shed has been completed by Edgar Allen and Co., Ltd., of Sheffield, for the new Swinegate depôt of Leeds Corporation. The lay-out comprises a new car fan with fifteen turnouts. The total length of the lay-out is 200ft., and the total length of manganese steel rail in the fan is 1415ft. The whole contract was executed within three months of the placing of the order. Some surprise has been expressed at the fact that Sheffield Corporation, which recently required 200 tons of tram rails, did not get them in the city, but placed the order at Middlesbrough. The fact is, however, that Sheffield does not roll tram rails, and never has done, except on a very small scale many years ago. I am told that the only place in the country where such rails are now rolled is Middlesbrough, where two works are equipped for the process, and the available trade is not sufficient to keep even them fully employed. Sheffield's 200 tons will provide work for one shift of eight hours! Railway metals are still rolled in this district—at Stocksbridge—but tram rails are larger and heavier, and of a totally different section. They require a heavier and more powerful plant, which it would not pay Sheffield to install. Manganese rails are not rolled, but cast in short sections of about 15ft., as against the 60ft. usual for tram rails.

Headgear Quickly Replaced.

Wooden headgear at a local colliery, which has been in use for many years, has just been replaced by steel headgear to cope with accelerated working. The pit concerned is the No. 2 shaft at Rockingham Colliery, belonging to Newton, Chambers and Co., Ltd., between Sheffield and Barnsley. The work was accomplished very quickly, the dismantling of the old equipment and the erection of the new only occupying nine days. The new headgear is 60ft. high to the centre of the pulleys, and is of rigidly braced construction to minimise the vibration effects. It was constructed in the works of the firm at Thorncliffe, near Sheffield, and the total weight of steel work in it is over 60 tons.

Machines for South America.

It is satisfactory to know that Sheffield is receiving trade as a direct result of the recent British Empire Exhibition at Buenos Aires. I have already reported the booking of an order for cutlery, and now comes the news that a South American company has given an order for 100 patented meat-tendering machines to British Weighers and Slicers, Ltd., a branch of Sheffield Steel Products, Ltd. The machines are designed for the purpose of separating the fibres of meat, so as to render it tender in cooking, whilst at the same time retaining the natural juices. They are an entirely new manufacture, and were exhibited at Buenos Aires for the first time. The series of knives, of which they mainly consist, are to be made of Sheffield stainless steel.

Cutlery and Plate.

Some firms engaged in the cutlery and plate trades are able to report rather better order books from ordinary distributors in this country, but exports continue poor, and there is little to relieve the state of depression which has existed so long. The summer trade with hotels and boarding houses at pleasure resorts is not equal to that of past years. A steady stream of orders is kept up by the large hotels and other catering establishments, but steamship requirements are below the normal. The most disappointing overseas market is Australia, in the case of which not only has buying declined heavily, but there is great difficulty in obtaining the payment of accounts. Retail ironmongers and tool dealers are continuing their opposition to the coupon trade, the production of goods for which has brought a large amount of work to Sheffield for several years. The articles given away in return for coupons include cutlery, silver, electro-plate, tools, and many hardware goods. At the Ironmongers' and Tool Dealers' Conference at Buxton last week, it was reported that pressure upon manufacturers to refuse to supply goods for coupon gift schemes had met with a certain amount of success, although handicapped by the existence of many "little masters." Among the local firms mentioned as having agreed to ignore the coupon trade were C. T. Skelton and Co., Ltd., tool manufacturers; George Butler and Co., Ltd., cutlery manufacturers; Joseph Rodgers and Sons, Ltd., cutlery manufacturers; Darwins, Ltd., safety razor manufacturers; Lockwood Brothers, cutlery manufacturers; Joseph Tyack and Sons, Ltd., tool manufacturers; and the Yorkshire Steel Company, Ltd., razor manufacturers.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Trade Outlook.

THE outlook in the iron and steel trade in the North of England at the moment shows no signs of improvement in any section. A cheerless tone pervades the market. Customers forced to make small purchases press for price concessions, and a fall in values seems inevitable if any buying movement is to be stimulated. Producers, however, declare that most commodities are now selling at little above cost, and are of the opinion that a reduction of quotations would not at present induce buying. There is at least one encouraging feature about the industry in this district. Although pig iron and steel output has been cut drastically, the North-East Coast has still the biggest output of any area in Great Britain. From this fact it may be inferred that the district is getting a full share of the business available, and that the depression is entirely due to external causes.

Cleveland Iron Trade.

The state of depression in the Cleveland iron trade is entirely unrelieved. Specially low prices quoted to Scottish consumers bring in very little business, and local works are only buying very small lots, being convinced that prices cannot much longer be maintained at the present level. Production will have to be further curtailed unless an unexpected expansion of demand occurs. Pig iron stocks continue to increase. Much of the restricted output is absorbed by producers' own works, and market transactions are chiefly direct between ironmasters and home consumers. No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

Excessive output of East Coast hematite pig iron is becoming somewhat embarrassing. Accumulations are increasing, and quantities already stored at works are heavy. Transactions are confined to narrow limits, and are chiefly between makers and home consumers, merchants being precluded from underselling producers in home markets. Prices tend downwards. For ordinary qualities 64s. is a full quotation, and No. 1 hematite is on sale at 64s. 6d.

Ironmaking Materials.

Business in the foreign trade is virtually at a standstill. The nominal price of best Rubio is 15s. 3d. c.i.f. Tees. Blast-furnace coke continues plentiful and difficult to dispose of. Sellers are pressing business on the basis of good average qualities at 15s. 6d. and even less for early delivery to North-East Coast works, but are not disposed to enter into forward contracts except on higher terms.

Manufactured Iron and Steel.

There is no fresh buying movement in the manufactured iron and steel trade, and overseas business is dull. It is, however, encouraging to note that a cargo of nearly 2000 tons of finished steel has been shipped this week from the Cleveland district to Canada. London continues to take substantial quantities of structural steel, and a few rail orders are to hand, but the flow of shipbuilders' specifications has almost dried up, and the sheet trade has quietened down considerably. Prices, however, are still maintained.

The Coal Trade.

In its main aspects the Northern coal trade has been more depressed since the beginning of June than in any other period this year. There is a striking dearth of orders, and much lost time is being experienced in both counties. Apart from the absence of trade, miners are being temporarily paid off, while owners take advantage of the slack times to modernise pit-head and other plant. Cleaning, grading and the more economical winning of

coal are receiving greater attention than ever in order that collieries may be prepared for any revival in the demand that may come later in the year. Prices are at the minimum and there is some curiosity as to whether there will be any revision in view of the dull conditions. At present there does not appear to be any disposition on the part of collieries to lower prices. To do so would mean, in their opinion, working at a loss. The latest ascertainment for Northumberland shows the trading profit to be only a halfpenny per ton. The next ascertainment may be worse, as there has been so much lost time. Best Northumberland steams are in fair demand for early shipment, and the undertone is steady. Some fitters have already cleared their quota, and have to remain idle for a day or two, with the result that ships in harbour are held up pending the arrival of cargo. Best qualities for this month are freely offered, being quoted unchanged at 13s. 6d. for large and 8s. 6d. for small. The prime Wear steam position is, on the whole, steady, but additional trade could be readily handled. Values are quoted at 15s. for large and 9s. for small. Tyne primes are quiet and in good supply at 12s. 9d. large and 9s. for small. Many of the gas coal pits in Durham are idle, and all grades are affected by the lack of trade. Best gas coal is quoted at 14s. 6d. and secondary at 13s. 3d. to 13s. 6d. Prime Wears are on the slow side, and output has occasionally to be curtailed to keep production down to actual requirements. Sellers quote unchanged at 15s. Coking unscreened coals are in poor request, and there is considerable idle time at numerous mines. Supplies of good quality are offered at 13s. 6d. The recent active demand for best bunkers is maintained, the tone being quite steady at 13s. 9d. to 14s. Good ordinary bunkers are easy in tone at 13s. 3d. to 13s. 6d. Gas coke values continue steady and the demand is fully up to recent average. Patent oven coke is in a depressed condition, and values remain unchanged at 14s. 6d. to 15s., and for superior coke at 17s. to 20s.

SCOTLAND.

(From our own Correspondent.)

Lifeless Markets.

MARKETS, as a rule, are without encouragement, and very little, if any, relief from the prevailing depression, either at home or abroad, is in evidence. Export markets are especially dull, and the state of the inquiry is not reassuring. Producers generally have, owing to the lack of specifications, to operate on a greatly reduced scale.

Steel.

Though here and there the inquiry has perhaps broadened enough to benefit one or two producers, consumers on the whole, and especially those usually absorbing considerable quantities, are unable to negotiate a tithe of their usual requirements. Costs of home materials are too high, and in this connection it is of interest to note the resolution on behalf of the Shipbuilding Employers' Federation calling for a reduction in the prices of plates and sections to bring them more into line with competitive continental quotations. Shipbuilding specifications are very scarce, and an early increase cannot be expected. Furthermore, competition abroad is becoming keener. American concerns are becoming more prominent in South American markets, especially those interested in the production of sheets. Home sheetmakers will also be affected by the announcement made by the Japanese Steel Sheet Union of its determination to quote prices for sheets produced in Japan calculated to prevent the importation of British material. On the other hand, the Australian market has reopened, although, of course, demands from there cannot be expected to reach respectable dimensions for some time to come. The outlook in the tube trade has improved a little, by virtue of inquiries of considerable importance, and though nothing definite has yet been concluded, substantial contracts are impending. Meanwhile, in all departments of the industry production is very much restricted.

Iron.

Makers of bar iron and re-rolled steel bars are hopeful of securing business for material for export to India and China, but otherwise nothing of interest has occurred of late. Prices are unchanged, re-rolled steel bars being quoted £6 10s. home and £6 7s. 6d. per ton export. Pig iron is without any feature of encouragement. Local producers are in a very difficult position. Home demands are poor and competition is keen, not only from continued arrivals of Indian iron, but also from English material. Locally, only seven furnaces are in operation, but outputs are apparently ample. Shipments of pig iron last week from Glasgow only totalled 67 tons (11 tons foreign), compared with 769 tons (710 tons foreign) in the same week last year.

Shale Mines to Close Down.

Owing to the state of trade and the reduction in the price of petrol, Scottish Oils, Ltd., will require to reduce operations, and several units will be closed down, thereby throwing some 2000 employees permanently idle. Five years ago conditions necessitated a reduction of about one-third in the output, and this further cut will leave less than one-half of the industry in operation, compared with the position at the close of the war.

Coal.

The depression in the Scottish coal trade is unrelieved. Practically without exception, demands are well below normal, and despite the curtailed output the amount of fuel on offer is more than ample. Washed nuts perhaps provide the exception, these being now scarce, especially in Fifeshire and the Lothians. Aggregate shipments amounted to 186,199 tons, against 214,196 tons in the preceding week and 259,341 tons in the same week last year.

Result of Polish Competition.

The announcement of the Swedish State Railway's allotments against recent tenders affords yet another illustration of the result of Polish competition. Out of a total of 204,000 tons, only some 35,000 tons have been allocated to Scotland.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

IT cannot be said that there has been any improvement in the general position of the coal export trade of this district during the past week. Orders for prompt loading continue to be inadequate to the needs of the collieries, and there is no loading pressure. Still, according to the returns of the G.W.R. Company, shipments last week were not unsatisfactory, considering all the conditions. The total came to 504,600 tons, which, of course, was a material advance upon the quantity for the preceding week, which was a holiday period; but it was less than the corresponding period of last year, when the total came to 568,464 tons. At the end of last week the number of idle tipping appliances was 31, with only one steamer waiting to berth, and on Monday the position was not much improved as the number was 24 and only three steamers were waiting. From this it will be seen that there is no pressure for coals, and as chartering operations have of late been on a reduced scale, it is difficult to see how there can be any immediate improvement. In addition to business for prompt shipment being quiet, the news regarding contract operations is not at all favourable. The supplementary order from the Buenos Aires Electricity Works for 120,000 tons of sized coals for delivery over 1932 has been secured by Germany. One of the leading Cardiff firms is now carrying out an order for about 400,000 tons of these coals, and this contract runs to the end of 1932. It was hoped that the supplementary quantity would also have come to this district, but, unfortunately, such is not the case. In some quarters the loss of this order is attributed to the uncertain outlook in the coalfield consequent upon the question of hours of work being reduced early next month and the fear of possible trouble on the wages problem; but whether this is so or not, the fact remains that the Germans undercuoted South Wales for the 120,000 tons inquiry. Furthermore, it is of no little interest to note that the penetration of the Germans into the South American markets is not inconsiderable, as, so far this year, they have shipped to the Argentine and Brazil over 100,000 tons more coal than they did during the corresponding period of last year. So far as the recent Swedish State Railways' inquiry for 196,000 tons of locomotive coals is concerned, by far the bulk of this order, as was expected, went to Poland, and the news now comes to hand that the Paris-Orleans Railway, which asked for prices for coals over the next two years, has decided not to operate. In patent fuel there is an inquiry from the Antwerp Port Works Department for 21,000 tons, and prices have to be in by the 15th inst. One important development in respect to the marketing side of this commodity so far as this district is concerned, is that at the end of this year a free market is to be re-established, except for Italy. The patent fuel works in South Wales are controlled by British Briquettes, Ltd., and at the present time the disposal of the various brands of fuel is in the hands of certain firms abroad. These monopolies, except in the case of Italy, are to be abolished at the end of this year, and the result will be that foreign consumers will be able to do business in Welsh patent fuel through their coal-exporting friends on this side.

Tin-plate Trade.

The market shows a rather better tone, and there is a fairly good demand for tin-plates at 14s. to 14s. 6d. Welsh bars have been reduced in price by 7s. 6d. to £4 12s. 6d. per ton.

Hours and Wages in the Coalfield.

The South Wales Coalowners' Association has sent to the South Wales Miners' Federation its proposals for the revision of the minimum percentage and the subsistence wages in the event of the 7-hour day operating from July 8th next. These proposals are made under clauses 11 and 19 of the new Wages Agreement, which entitles either party to apply for a review of the existing minimum percentages and subsistence wages before any statutory change in the hours of work comes into force. This procedure does not involve points concerning notices for the termination of the agreement or the contracts of employment. If the hours of work are reduced from 7½ to 7, the owners' proposals, failing agreement between the owners and the workmen's leaders, will be submitted to the independent chairman, whose casting vote for or against will be binding upon both parties, and his decision will become operative from the time that the hours of work are reduced. Should there be no alteration in the working hours, then the owners' proposals are automatically withdrawn. The owners' proposals involve application for a reduction of the minimum percentage payable on the 1915 standard rates from 20 to 12 per cent.; the three grades of subsistence wages of 7s. 6d., 7s. 3d. and 7s. are to be reduced by 3d. per day in each case, and the allowance of 4d. per shift to boys between 16 and 21 is to be discontinued. A new agreement came into operation on Monday last so far as the men engaged at the Taff-Merthyr Colliery are concerned. There are about 1500 men employed at this colliery, and they are all members of the South Wales Industrial Union. The new agreement was signed by representatives of this organisation and the officials of the colliery, and it provides that all men doing the same class of work shall receive the same rate of pay, irrespective of family obligations. Piece-workers suffer a slight reduction in percentage rates, but the day-wage men's position will be improved, and the lowest wage to be paid under the agreement will be 7s. 4½d. per day to the labourers. Since the coalfield stoppage in the early part of this year the workmen at this colliery have had the same wages and conditions as before the stoppage. No attempt was made to give effect to the award of the independent chairman, and as a result the workmen have benefited by thousands of pounds, and it is interesting to note that the men received a bonus of £1 each for their loyalty in working during the period of the stoppage.

S.W.M.F. Finances.

The balance sheet of the South Wales Miners' Federation shows that after allowing for a total expenditure of £36,440 2s. 7d., the total funds of the Federation on December 31st last amounted to £91,901, as compared with £74,168 on December 31st, 1929. The average membership during 1930 was 75,480.

Miscellaneous Items.

There has been another hitch in the agreement for the resumption of work at the Landore Works of the British Mannesmann Tube Company. These works were supposed to re-open on Monday, but were not restarted. The men's complaint now is that the company is not observing the seniority rule in taking on workmen. The Villiers Tin-plate Works, Briton Ferry, which have been at a standstill for the last five months, restarted four of its seven mills on Monday, thus finding work for about 200 men. During the stoppage the owners have made a number of alterations and improvements to the works, which become among the most up-to-date in the district. Reports to hand show that there is some doubt about the continuance of work at the Swansea Vale Spelter Works, owing to the further decline in the price of spelter. To enable work to be continued the men were balloted as to whether they would accept wage reductions based on a new standard price for spelter, the reductions to be modified in the event of the price increasing. Since the men accepted the proposals put before them the price of spelter has fallen another 15s. per ton.

Current Business.

There has been no appreciable expansion in business for prompt loading, and the conditions generally are quiet in the steam coal trade. Most of the leading collieries, particularly some of the Monmouthshire undertakings, are well placed for orders for large coals, but sized coals are not too brisk in demand, while small coals are as dull as ever. Coke and patent fuel remain without any new feature, while the demand for pitwood is restricted and the price is about 22s. 9d. to 23s.

LAUNCHES AND TRIAL TRIPS.

PAN BOLIVAR, single-screw steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Pan American Petroleum and Transport Company, of New York; dimensions, 483ft. by 65½ft. by 36½ft.; to carry oil in bulk. Engines, triple-expansion; constructed by Wallsend Slipway and Engineering Company, Ltd.; launch, May 19th.

CORFU, steamship; built by A. Stephen and Sons, Ltd.; to the order of the P. & O. Steam Navigation Company, Ltd.; dimensions, 545ft. by 71ft. by 46ft.; to carry passengers and cargo. Engines, two sets single-reduction geared turbines of the Parsons type; constructed by the builders; launch, May 20th.

MARACAY, steam tanker; built by Harland and Wolff, Ltd.; to the order of the Lago Shipping Company, Ltd.; dimensions, 350ft. by 60ft. by 17ft. 6in.; to carry petroleum in bulk. Engines, triple-expansion, pressure 180 lb. per square inch; launch, May 21st.

MOYRA, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Inter-Provincial Steamship Lines, Ltd.; dimensions, 257ft. by 39ft. 6in. by 24ft. 4in.; to carry cargo. Engines, triple-expansion; constructed by the builders; trial trip, May 23rd.

CARDITA, oil tanker; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Anglo-Saxon Petroleum Company, Ltd.; dimensions, 450ft. by 62ft. by 34ft.; to carry oil in bulk. Oil engines of Hawthorn-Werkspoor design; constructed by R. and W. Hawthorn, Leslie and Co., Ltd.; launch, May 28th.

CONUS, twin-screw motor oil tanker; built by Workman, Clark (1928), Ltd., to the order of Anglo-Saxon Petroleum Company, Ltd.; dimensions, 465ft. by 62ft. by 34ft.; to carry oil in bulk. Oil engines of Werkspoor type; launch, May 28th.

TUG, steam; built by Richard Dunston, Ltd., to the order of London and North-Eastern Railway Company; dimensions, 65ft. long; handed over to owners at Grimsby after successful trial trip, June 3rd.

CATALOGUES.

ALFRED HERBERT, Ltd., Coventry.—Ninth edition of "The Book of the Coventry Diehead."

DANIEL ADAMSON AND CO., Ltd., Dukinfield.—Publication No. 202 dealing with superheaters.

CROFTS (ENGINEERS), Ltd., Thornbury, Bradford.—Catalogue V.G. 730 on "Variable Speed Gears."

COVENTRY MACHINE TOOL WORKS, Ltd., St. George's-road, Coventry.—A catalogue on forging machines.

SAMUEL FOX AND CO., Ltd., Stocksbridge, near Sheffield.—A pamphlet on "Durhete" creep-resisting steel.

MAINTENANCE SCHOLARSHIPS IN ARCHITECTURE.—The Royal Institute of British Architects offers for award in July next two Maintenance Scholarships in Architecture. One scholarship is the Artists' General Benevolent Institution Maintenance Scholarship of a maximum value of £100 per annum. This scholarship is open only to orphans or sons or daughters of architects or artists, and is restricted to applicants in England and Wales. The second scholarship is the Ralph Knott Memorial Scholarship, tenable at the School of Architecture of the Architectural Association, London It is of a value of about £45 per annum, and is available for applicants in England, Scotland and Wales. The scholarships will be tenable in the first instance for one year and will be renewable for two further periods of one year each. They are intended to enable students who have not the necessary means to attend an approved course at one of the schools of architecture recognised for exemption from the R.I.B.A. Examinations (the Ralph Knott Memorial Scholarship being tenable only at the Architectural Association School of Architecture). Students who are already taking such a course are also eligible to apply for a scholarship. Particulars and forms of application may be obtained free on application to the Secretary to the Board of Architectural Education, R.I.B.A., 9, Conduit-street, London, W. 1. The closing date for the receipt of applications, duly completed, is Saturday, July 4th, 1931.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/– to 20/6
(1) Spanish	16/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	15/3

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 10 0	—
No. 1 Foundry	3 13 6	—
No. 3 Foundry	3 11 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 4 0	3 4 0
No. 1	3 4 6	3 4 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
,, ,, Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 19 6 (*a*), 4 1 6 (*b*), 4 6 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
LANCS.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 5 0	—
S. YORKS.—		
Crown Bars	10 0 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 10 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 10 0 to 9 0 0	—
Gas Tube Strip	10 17 6 to 11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
,, ,, (Land)	10 10 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 10 0 to 7 15 0	8 0 0
Sheets (Gal. Cor. 24 B.G.)	11 7 6	11 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
,, ,, (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
,, (Small Round)	6 15 0	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
,, (Lancs. Boiler)	9 0 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	7 2 6	—
Soft Basic	6 0 0 to 6 5 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 15 0	—
MIDLANDS—		
Small Rolled Bars	6 10 0 to 7 5 0	—
Billets and Sheet Bars	5 0 0 to 5 15 0	—
Galv. Sheets, f.o.b. L'pool	10 5 0 to 10 10 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	14/– to 14/3
Block Tin (cash)	100 15 0
,, (three months)	102 7 6
Copper (cash)	35 3 9
,, (three months)	35 18 9
Spanish Lead (cash)	10 17 6
,, ,, (three months)	11 6 3
Spelter (cash)	10 5 0
,, (three months)	10 16 3
MANCHESTER—	
Copper, Best Selected Ingots	38 10 0
,, Electrolytic	40 0 0
,, Strong Sheets	70 0 0
,, Tubes (Basis Price), lb.	0 0 10½
Brass Tubes (Basis Price), lb.	0 0 9½
,, Condenser, lb.	0 0 11½
Lead, English	12 17 6
,, Foreign	11 15 0
Spelter	11 10 0
Aluminium (per ton—raw ingot)	£85

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11½ per lb.	
Ferro Tungsten	1/8½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 0 0	7/–
,, ,, 6 p.c. to 8 p.c	£20 0 0	7/–
,, ,, 8 p.c. to 10 p.c.	£20 0 0	7/–
,, ,, Specially Refined		
,, ,, Max. 2 p.c. carbon	£31 0 0	10/–
,, ,, ,, 1 p.c. carbon	£34 0 0	12/–
,, ,, ,, 0·70 p.c. carbon	£36 0 0	14/–
,, ,, ,, carbon free	10d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
,, ,, ,,	£11 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£10 10 0 scale 5/– per unit	
,, ,, 75 p.c.	£15 0 0 scale 7/– per unit	
,, Vanadium	12/9 per lb.	
,, Molybdenum	4/2 per lb.	
,, Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170	
Ferro Cobalt	9/– per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/–
,, ,, Ell	14/– to 14/6
,, ,, Splint	14/6 to 16/–
,, ,, Trebles	11/6
,, ,, Doubles	10/6 to 11/–
,, ,, Singles	9/– to 9/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/–
,, ,, Jewel	17/–
,, ,, Trebles	11/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	10/3 to 12/–
Screened Navigation	16/6 to 17/6
Trebles	11/6 to 13/–
Doubles	10/9
Singles	9/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/–
Secondary Steam	10/6
Trebles	12/–
Doubles	11/–
Singles	9/6

ENGLAND.

	Inland.
(8) N.W. COAST—	
Steams	20/–
Household	30/– to 51/–
Coke	20/– to 20/6
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	12/–
Steam Smalls	7/6 to 8/–
Unscreened	12/6 to 13/–
Household	27/– to 39/–
DURHAM—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–
SHEFFIELD—	
Best Hand-picked Branch	25/6 to 27/–
Derbyshire Best Bright House	20/– to 22/–
Best House Coal	20/– to 21/–
Screened House Coal	18/– to 19/–
,, ,, Nuts	15/– to 16/–
Yorkshire Hards	15/– to 16/6
Derbyshire Hards	15/– to 16/6
Rough Slacks	9/– to 10/–
Nutty Slacks	7/– to 8/–
Smalls	4/6 to 6/6
Blast-furnace Coke (Inland)	12/3 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b.	14/– to 15/–

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/– to 20/3
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/6
Ordinary Dry Large	17/9 to 18/–
Best Black Vein Large	18/3 to 18/9
Western Valley Large	18/– to 18/6
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/9 to 18/–
Best Steam Smalls	13/6 to 14/–
Ordinary Smalls	11/6 to 13/3
Washed Nuts	18/– to 21/–
No. 3 Rhondda Large	19/9 to 20/3
,, ,, Smalls	15/– to 16/–
No. 2 ,, Large	17/– to 17/3
,, ,, Through	15/6 to 16/–
,, ,, Smalls	14/– to 14/3
Foundry Coke (Export)	22/– to 36/6
Furnace Coke (Export)	16/6 to 17/6
Patent Fuel	20/– to 20/6
Pitwood (ex ship)	22/6 to 22/9
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 45/–
Nuts	43/– to 46/–
Beans	24/9 to 28/3
Peas	21/– to 21/9
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/6 to 9/6
Steam Coals :	
Large	20/6 to 21/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Steel Organisation.

A further decline of rolled steel prices on the international market has had the effect of eliminating many German makers who prefer to continue their policy of restricted output rather than accept business that can only be transacted at a loss. In Belgium, mill and forge owners are believed to be making sacrifices in order to increase their foreign business as a means of obtaining a larger quota of trade when the Steel Cartel is reorganised, and the French production, though steadily falling, is resisting the collapse which has become particularly marked in Germany. An attempt is now being made in France to form a syndicate of merchants for the maintenance of bar prices. Each seller would continue to deal directly with his customers, but the orders would have to be approved of by the syndicate, which would also be empowered to ensure an equitable distribution of orders. The great trouble is to arrive at some arrangement which would give satisfaction to those merchants who have sole contracts with rolling mills, and are obliged to carry heavy stocks. Meanwhile, the restricted business and the collapse of prices have centred interest in the negotiations for the reconstitution of the Steel Cartel, which is recognised as offering the only means of saving the steel industry from ruin. A meeting was held last week at Luxemburg, and another is to take place at Budapest, when it is hoped that some settlement will be reached for ensuring the renewal of the Cartel at the end of the month. It is hoped that when the Cartel is definitely reconstituted on the new lines, and prices for export are likely to be stabilised by the fixing of quotas for foreign trade, buyers will hasten to enter the market in anticipation of an advance. Nevertheless, it is by no means certain that the Cartel will do all that is expected of it, in view of competition from countries that remain outside. In the case of the Rail Union, some German firms urge that the prices of rails should be reduced in order to meet Japanese competition. The renewal of the wagon builders' Cartel at the end of the year has become problematic, on account of the conflict between German and Belgian makers, the latter having taken an important order for wagons without consulting the syndicate, and the Germans have not obtained full satisfaction over the penalties which they ask that the Cartel should inflict upon the Belgian firms.

Suspension Bridge Collapse.

The collapse of a suspension bridge across a tributary of the river Dordogne, at Saint-Denis-de-Piles, near Libourne, last week, resulted in twelve deaths and a number of persons being injured. The bridge had replaced a similar structure with a wood roadway, and in the new one, which has a length of 80 m., the roadway, which was suspended from cables and was of reinforced concrete, was being tested by loading the bridge with lorries. Ten laden lorries had run on to the bridge when the roadway broke from the suspenders, and all the drivers were pinned under the vehicles in the water. Engineers and officials were badly injured in the fall and two of them died. The engineer, who was noting the flexion of the bridge under the load, says that as the lorries proceeded along the bridge one of them struck the balustrade, and stopped, thus stopping the other vehicles. There was a sound of repeated snapping as the roadway broke from the suspenders one after the other. The bridge was not fully loaded, as there were six other lorries waiting to go on.

German Reparations.

The report that Germany contemplates asking for a moratorium of the Young Plan is complicating an already difficult industrial situation, for if the operation of the plan is suspended the payment of reparations in kind will automatically come into force. The French Government is probably the only one that is inclined to accept reparations in kind, and it would not hesitate to take what it could from Germany, if, by so doing, it could help forward the scheme of national equipment which has been held up since the supply of German material was practically stopped by the Young Plan. So long as Germany was contributing to the national equipment scheme, there was employment and some work for manufacturers who were supposed to receive orders equal in value to what was supplied by Germany, but, as a matter of fact, French makers complain that they did not get their share of the business, and the effect of the reparation supplies of machinery and material was to create a formidable competition of German goods in France. In the present state of trade, the Government is being urged to carry through the programme of public works, which would be greatly facilitated if Germany resumed her contribution, but this is causing considerable uneasiness to French manufacturers, who say that if anything is taken from Germany it should be strictly limited to machinery and material that are not produced in France.

The Canal du Nord.

The construction of a canal from the northern collieries to Paris of sufficient capacity to allow of an accelerated heavy traffic has for years been urged by those who believe that it would enable French coalowners to drive out the 12 to 15 million tons of British coal at present imported yearly into the Paris district. It was hoped to include the scheme in the programme of public works, but the Government does not view with favour the carrying out of an undertaking which would cost between 600 and 800 million francs with only theoretical possibilities of commercial success. All these attempts to oust British coal from the market are doomed to failure, for the reason that French coal of an inferior quality cannot compete in price with the water-borne British fuel.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

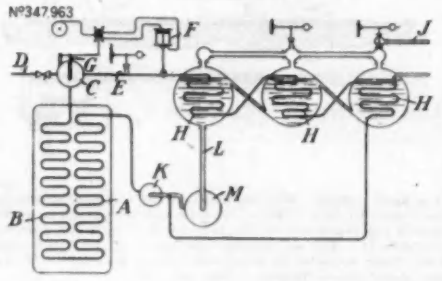
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

347,963. July 1st, 1930.—High-pressure Boilers, W. Huntermüller, Lindenstrasse 257, Düsseldorf, Germany.

This boiler is intended to work at a pressure of 225 atmospheres, when water and steam have the same density. The water is evaporated in the coil A and superheated in the coil B. There is a steam drum C, which supplies the engine or turbine through the pipe D. In order to prevent the coils from being overheated in the event of the demand for steam being reduced, surplus

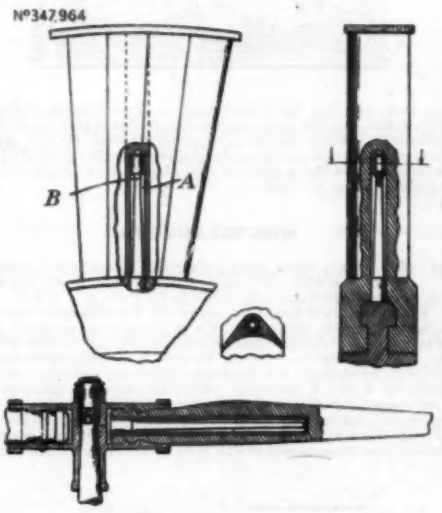


steam is drawn off by the pipe E and the flow is regulated by the servomotor F and the thermostat G. This steam passes through the coils H H H and heats feed water. Any steam which may be generated in the heaters is led away by the pipe J. The cooled high-pressure steam is circulated back into the evaporating coil A by the pump K, while the warmed feed water delivered by the pipe L is forced into the boiler by the pump M. The pumps K and M are, in reality, embodied in one casing.—*May 7th*, 1931.

TURBINE MACHINERY.

347,964. July 4th, 1930.—Vibration Damping Devices for Turbine Discs and the Like, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

This invention is concerned with the vibration of steam turbine blades, and aero propellers, which is produced by the rapid variation of the propulsive forces. The blades are hollowed out as shown at A, and within this hollow there protrudes a stalk B, securely attached to the blade disc. The intervening space is

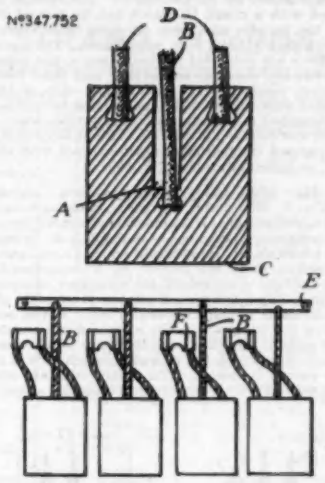


filled with oil or mercury. The proportions of the stalk and of the blade are such that they have different periodicities of vibration. The liquid filling between the stalk and the hollow in the blade provides a damping effect between the two parts, and the interference of one vibration with the other militates against the exaggeration of either one. There is a hint in the specification that it may not be necessary to provide all the blades of a ring with the device.—*May 7th*, 1931.

DYNAMOS AND MOTORS.

347,752. February 3rd, 1930.—Dynamo-electric Machines, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Harold Orchard, of 30, Claremount-road, Rugby, Warwickshire.

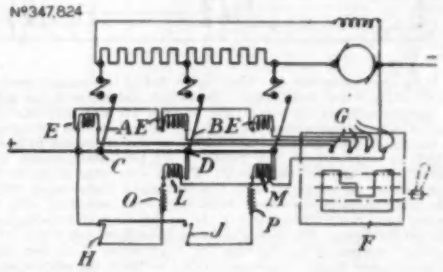
This invention relates to commutating dynamo-electric machines and particularly to machines required to carry heavy currents, such as large current D.C. generators and rotary converters of high capacity. Such machines are provided with parallel connected brushes and are frequently subject to selective commutation of the brushes—that is, a tendency for one brush of the group to carry more than its share of the current. The invention consists in providing means for distributing the overload on a single brush between the several parallel connected brushes before it is passed through the main pigtails or other contact arrangement of the individual brush. A deep recess A is provided within each brush, and an additional or separate pigtail B is embedded into the brush at the bottom of this recess so that the actual connection of the pigtail B takes place within the body of the brush between the working surface C and the points at which the main contact pigtails D are connected. The pigtail conductor B should be insulated or spaced from the brush from the point at which it is embedded into the material of the brush, so that the current carried by it is taken solely from the point at which it is embedded into the material. As shown in the lower illustration, the additional pigtails B of several parallel connected brushes are interconnected by an auxiliary isolated conductor or bus E. The usual brush gear



connecting devices are shown at F. By means of the auxiliary bus E, an overload on an individual brush is prevented from being carried by the main contact-carrying device for each brush and is distributed between the several parallel-connected brushes.—*May 4th*, 1931.

347,824. March 18th, 1930.—Means for Controlling Electric Motors, Clarke, Chapman and Co., Ltd., and Archie Read, both of Victoria Works, Gateshead-on-Tyne, Durham.

When electric motors are controlled by automatic contactor gear, a delay action is generally necessary or desirable to prevent too rapid acceleration, as well as to prevent sudden rushes of current from the supply. The object of this invention is to enable the desired delay action of a motor starter to be obtained in an improved manner. In the example shown, the movable members A B of the first and second contactors C D of a three-contactor controller—the operating coils E of which are connected across the supply mains through a drum F and contacts G—each have an auxiliary contact, such as H or J, adapted to close the circuit of shunt lock-out coils L M for the second and third contactors respectively, through series resistances O P of nickel, the value of each shunt coil and size

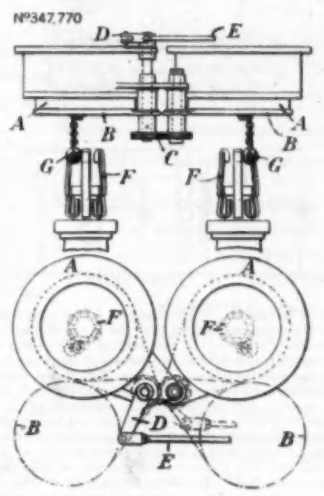


of the nickel resistance being so calculated that the resistance will rise in temperature when the line voltage is applied across it. In this way on the starter being used, the first contactor C will immediately close and will close the auxiliary contact H in the circuit of the lock-out coil L on the contactor D. As the nickel resistance O in series with this lock-out coil L is cold, a large current will pass through it, preventing the second contactor D from closing, even if the operator has passed this step on his control. On the nickel resistance O having warmed up, the current in the associated lock-out coil L will have decreased materially and allow the second contactor D to close. The lock-out coil L can be adjusted to give any length of time delay required. The operation of the third contactor will simply be a repetition of this process, from which it will be obvious that as many contactors as required can be used.—*May 7th*, 1931.

SWITCHGEAR.

347,770. February 7th, 1930.—Electric Switchgear, A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, Durham, and John Christie, of 4, Sidecliff-road Sunderland.

In draw-out switchgear, used on high and extra high-voltage

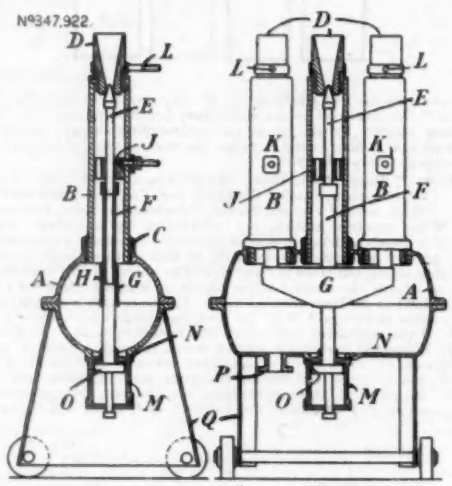


systems, there is a risk that, although the withdrawn contact is out of connection with the rest of the circuit, it or its bushing may retain a high and dangerous potential charge. In electric

switchgear, according to this invention, this risk is obviated by the provision of an earthing member. In the drawing the ends of the usual spouts or orifices which surround the fixed contacts of the switchgear are shown at A. Each spout is provided with a shutter or locking-off door B, the two doors being pivoted and geared together by the pinions C. The spindle of one door is furnished with a crank D, which can be moved by a rod E to rotate the spindle and open or close both doors when the movable contacts F have been withdrawn. The open positions of the shutters are indicated in chain lines in the lower drawing. In order that the movable contacts F and their bushings may be effectively earthed when withdrawn, each of the shutters B is provided with a metal ball G suspended by a chain and electrically connected to the shutter by a flexible wire. This suspended ball is so disposed in relation to the shutter that when that member is closed the ball comes into contact with the movable contact F, as indicated.—*May 7th*, 1931.

347,922. May 27th, 1930.—MULTIPLE-POLE COMPRESSED AIR BLOW-OUT ELECTRIC SWITCH, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention relates to a multiple-pole compressed air switch, in which the arc is extinguished by a compressed air blast, and the switch parts are moved by a compressed air drive. A is a cylindrical compressed air container composed of two parts for the compressed air. B are the blast-pipes of the three-pole switch, made of paper board or solid woven material and cemented in the flanges C in the intermediate container A. In the upper ends of the blast-pipe there are nozzle-shaped hollow switch parts D in which the movable switch rods E are inserted when the switch is closed. The switch rods are connected by insulating tubes F with a cross piece, consisting of two iron plates

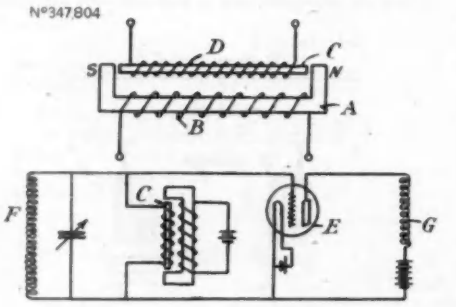


G H in the container A. The piston-rod of the compressed air drive engages the cross piece. The switch rod slides in the guide J which serves at the same time to take off the current. The current supply takes place through the bolts K, whilst the current is taken off through the bolts L. M is the operating cylinder, which is screwed on the flange N of the intermediate container. O is the driving piston. P is a connector piece for the compressed air supply. Q is the travelling frame upon which the intermediate container is fitted. On switching off, the switch rods E are drawn out of the nozzle-shaped switch pieces and pulled down. The compressed air then flows out of the intermediate container A, through the blast-pipes B to the blast-nozzles D and blows out the arc drawn between the switch parts.—*May 7th*, 1931.

TELEGRAPHS AND TELEPHONES.

347,804. February 28th, 1930.—ELECTRO-MECHANICAL RESONATORS, *Marconi's Wireless Telegraph Company, Ltd., of Marconi House, Strand, London, W.C.* 2.

This invention relates to electro-mechanical resonators utilising the phenomenon of magneto-striction, and more particularly to electro-mechanical oscillators having the frequency controlled by the period of mechanical vibration of a magneto-strictive vibratory body. The electro-mechanical oscillator or resonator comprises a magnet A, generally of U shape, having a coil B, the terminals of the coil being connected to any suitable D.C. supply, which serves to polarise the magnet. In the field of the magnet between the north and south poles a vibrator rod C of any suitable magnetic material is supported, the dimensions of the rod being such that it has a predetermined natural period of vibration. The terminals of the coil D on the vibrator are connected to the A.C. source, upon which the oscillator is to exercise control. The operation of the device may

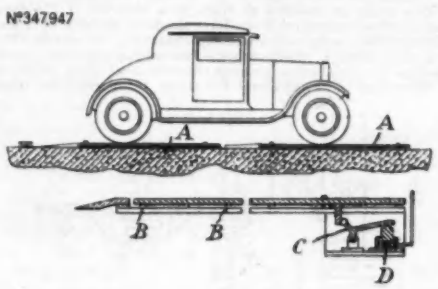


be described as follows :—The magnet A has a normally constant magnetic field owing to the flow of D.C. through the coil B. When the rod C is placed in the field of the magnet A, as shown, there is a certain change in dimensions of the rod C, owing to the action of the magnetic field. When A.C. flows through the coil D it produces variations in the strength of the field of the magnet A, thus causing variations in the dimensions of the rod C. The variations in the dimensions of the rod follow the variations in the effective magnetic field acting thereon, and it therefore follows that if this field is varied periodically, at a certain frequency, the rod will respond and vibrate at that frequency. It has been found that when the frequency of the A.C. flowing through the coil D is substantially in resonance with the natural period of mechanical vibration of the rod, the rod vibrates at a maximum amplitude, and the reaction of the rod upon the A.C. circuit is very powerful. The lower illustration shows an electro-mechanical resonator connected to a valve circuit for the purpose of maintaining the frequency of oscillation of the valve constant. The valve E is provided with the usual input and output circuits F and G respectively. The coil C of the resonator is connected between the grid and filament of the valve. It therefore follows that when the frequency of current flowing in the input circuit of the valve is in resonance with the mechanical period of vibration of the vibrator rod C the latter will react powerfully upon the input circuit and maintain the frequency of oscillation of the valve constant.—*May 7th*, 1931.

MOTOR CARS AND ROAD TRAFFIC.

347,947. June 16th, 1930.—A BRAKE TESTING MACHINE, H. F. Scruby, 810, Benedict Canyon, Beverley Hills, Los Angeles, California.

In this machine low platforms A A are provided for each wheel of the car to be tested. These platforms are supported on anti-friction bearings B B and are free to move longitudinally

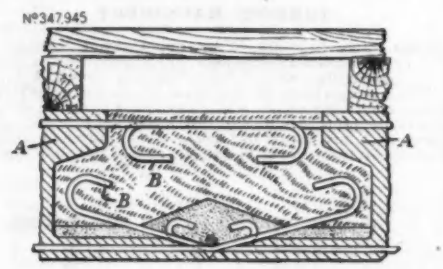


to a small extent. The car is driven on to the platforms and the brakes applied. The reaction presses the platforms forward against the resistance of the bell cranks C and the pneumatic cylinders D. The air pressure produced in these cylinders is individually recorded by gauges and shows the relative effectiveness of the several brakes.—*May 7th*, 1931.

BUILDING.

347,945. June 13th, 1930.—REINFORCED CONCRETE GIRDERS, *A. M. Plack, Imperial Buildings, Ludgate-circus, London, E.C.* 4.

In this floor construction the main support is provided by reinforced concrete joists, of which two half-sections are shown at A A. The longitudinal reinforcement of these joists is not

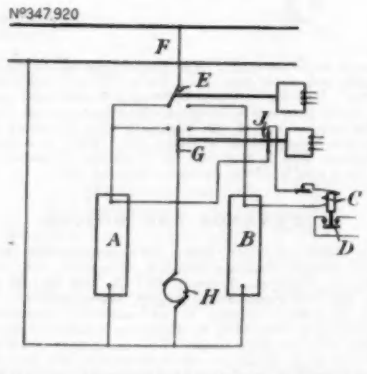


specified, but they have transverse reinforcement, as shown at B B, which extends beyond the joist and is bent over in hook formation. These hooks are accommodated in the spaces between the joists and are embedded in concrete placed after the arrangement of the joists. In this way the joists enjoy mutual support.—*May 7th*, 1931.

MISCELLANEOUS.

347,920. May 26th, 1930.—BATTERY CHARGING, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

The invention relates to a device for automatically charging a battery, more particularly for automatically operated sub-stations, in which the signalling and controlling circuits are fed by an accumulator. As the battery A feeding the network becomes exhausted, the potential difference between the two batteries A and B increases. When the potential difference or the compensation current flowing through the relay C has reached a certain value, the relay operates and closes its contacts D. In this way a circuit, not shown in the diagram, is closed, causing the change-over switch E to be thrown over, so that the



network F is now fed by the battery B. In addition, the charging switch G connects the charging machine H to the battery A, and the circuit of the relay D is opened by the switch J. When charging is complete, the switch G is thrown automatically into its middle position, and at the same time the circuit of the relay C is thereby closed across the switch J. If the battery B then becomes discharged, the relay C again operates. In certain circumstances, it is possible for a battery, although discharged, not to show a sufficient drop in voltage, owing to a small load. In order to avoid the battery standing for a long time discharged the battery may be loaded automatically from time to time by a resistance, so that if the battery is already discharged, the potential difference required to operate the relay C will be produced.—*May 7th*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY AND SATURDAY, JUNE 13TH.

NEWCOMEN SOCIETY.—Summer meeting at Sheffield. For programme see page 637.

TO-DAY TO SUNDAY, JUNE 14TH.

INSTITUTE OF TRANSPORT.—Italian Tour and Congress. For provisional programme see page 359.

TUESDAY, JUNE 16TH.

OLD CENTRALIANS.—Devereux Restaurant, Devereux-court, Strand, W.C. 2. Luncheon at 1 p.m.

WEDNESDAY, JUNE 17TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON): BIRMINGHAM CENTRE.—Visit to the Austin Motor Company, Ltd., Coventry Works. 2 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Afternoon visit to York.

SOCIETY OF GLASS TECHNOLOGY.—In the Applied Science Department, The University, St. George's-square, Sheffield. "An Investigation of the Flow of Glass in Tank Furnaces by the Use of Barium Oxide," by Mr. J. C. Bowmaker and Mr. E. J. D. Cauwood; "A Comparison between the Ordinary Thermo-couple and Suction Pyrometers for the Measurement of Flowing Gases in Glass Furnaces," by Mr. M. Parkin and Mr. F. Winks; "The Density of Sodium Metasilicate Silica Glasses," by Mr. F. Winks and Professor W. E. S. Turner; "Glass-making in Lorraine," by Mr. E. Graham Clark; "Note on Heat-absorbing Glass," by Mr. A. F. Dufton (a communication from the Building Research Station, Garston). Discussions. Report of the Joint Meeting of Technical Committees in Germany. 2 p.m.

WEDNESDAY TO SATURDAY, JUNE 17TH TO 20TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Birmingham. Fifty-eighth annual general meeting and conference. For programme see page 524.

WEDNESDAY, JUNE 24TH.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Annual excursion. Visit to the National Physical Laboratory, Teddington.

MONDAY TO SATURDAY, JUNE 29TH TO JULY 4TH.

INSTITUTION OF NAVAL ARCHITECTS.—Paris summer meeting. For programme see page 514.

SECOND INTERNATIONAL CONGRESS OF THE HISTORY OF SCIENCE AND TECHNOLOGY.—For programme see page 524.

THURSDAY, JULY 9TH.

BRITISH ELECTRO-FARMING CONFERENCE.—In the Members' Large Tent, Royal Agricultural Show, Warwick. Sixth Conference. "Electricity on the Farm, including Dairy and Poultry Farming," by Mr. M. M. Harvey. 3 p.m.

MONDAY TO SATURDAY, JULY 13TH TO 18TH.

SOCIETY OF CHEMICAL INDUSTRY.—Jubilee Celebrations. For provisional programme see page 471.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

E. G. HERBERT, Ltd., of Manchester, has appointed A/S Danish Machine Company, Bredgade 25 C, Copenhagen, as sole agent for sawing equipment for Denmark. A representative stock will be carried by the firm.

MR. F. THEAKSTON, M.I. Mech. E., has been appointed a director of Robert Hudson, Ltd., of Leeds. Mr. Theakston will be in charge of the London offices at Suffolk House, Cannon-street, E.C. 4. Telephone number, Mansion House 7772.

NEW DISTRIBUTORS OF EDISON STORAGE BATTERIES, Ltd., have changed their name to Edison Storage Battery Distributors, Ltd. The head office of the company will be as before, Victoria House, Southampton-row, London, W.C. 1, and the telephone numbers —Holborn 6673/4—are unchanged.

CONTRACTS.

SIR WILLIAM ARROL AND CO., Ltd., of Glasgow, have received an order for one 3-ton overhead electric travelling crane for coal handling from the Director of Army Contracts.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., of Loughborough, has received an order for two 1250-kW Brush-Ljungström turbo-alternators from the municipality of King William's Town, South Africa.

BLACKSTONE AND CO., Ltd., of Stamford, have received an order from the Preston Corporation for an automatically controlled plant consisting of three 16in. and two 12in. Blackstone "Unchokeable" pumps for the handling of unscreened sewage, together with motors totalling 835 B.H.P., and complete with switchgear, pipes, &c.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., has received orders for brakes from the following firms :—Metropolitan-Cammell Carriage, Wagon and Finance Company, 145 sets for motor cars; Birmingham Railway Carriage and Wagon Company, 90 sets for trailers; Gloucester Railway Carriage and Wagon Company, 40 sets for trailers. The equipment in each case is to be of the Westinghouse Company's latest type of electro-pneumatic interlocked brake.

STEERING GEAR FOR THE NEW CUNARDER.—We are asked to correct a widely circulated statement in the daily papers that the steering gear for the new Cunarder being built by John Brown and Co., Ltd., Clydebank, has been ordered from Vickers-Armstrongs, Ltd. Actually this steering gear is being built complete by Brown Brothers and Co., Ltd., at their works in Edinburgh, to the order of John Brown and Co., Ltd., with the exception of auxiliary parts, which are normally purchased from sub-contractors. The pumps which form part of this gear are being supplied by Vickers-Armstrongs, and the electric motors by Laurence Scott and Co., Ltd.